POWER

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TOMORROW

• "WHAT IS THE FUTURE of industrial power?" asks the young engineer, thinking ahead to his life's work. One hears the same question from gray-haired chiefs in their offices. To all such POWER conveys its sincere belief that the future of the industrial power plant will be greater than its past, and that this field will more and more demand—and pay for—real technical and managerial ability. Here are some facts that point the trend:

• TEN YEARS AGO, in many sections, industrial prime movers were falling right and left. The swing to purchased current became an epidemic, sweeping away many sound industrial power plants along with the unsound ones.

• YET, AT THE LOW POINT, as the pendulum started back to correct the excesses of salesmanship, the total kilowatt capacity of industrial prime movers approximately equalled that of central stations. Industrial boiler capacity was several times greater.

• EVERY PRESENT INDICATION points to a continued growth in the total capacity of industrial prime movers and boiler plants. Even the small industrial plant, where economical power generation has generally been thought to be out of question, now finds the diesel engine worthy of consideration.

• IN THE LARGE INDUSTRIAL ESTABLISHMENTS, the relative position of local generation seems likely to improve as more intelligent use is made of pressures, equipment, cycles and hook-ups now available. Even now, local generation is practically impregnable in the large industrial plants with heavy process loads. The reasons for this are well understood by all power engineers and also (in a general way) by a growing number of top industrial executives.

• LOWER ELECTRIC RATES HAVE BEEN PREDICTED by many observers. How will these affect this picture of local generation? Lower industrial rates would tend to cut in on marginal industrial prime movers, but one must remember that both the political pressure for rate reduction and the available margins for such reduction are mainly in the domestic schedules. Moreover, the effect of slightly lower industrial power rates might be completely offset by moderate advances in the technique of industrial power generation.

• FINALLY, DON'T FORGET that the prime movers are a mere fraction of the power-service equipment of industry. If the impossible should happen, and every industrial prime mover be thrown on the scrap heap, eighty per cent of America's industrial power equipment would still operate. Boilers, pumps, compressors, systems of refrigeration, heating, ventilating and air conditioning, would remain—and with them more motors than ever.

• THE POINT OF ALL THIS is that the expectant mourners at the "funeral" of the industrial plant —and these include some industrial power engineers—might as well dry their eyes and tuck away their handkerchiefs. It's one of those things that never happened and never will in their lifetimes. The young man entering this field has only one proper worry: Does he know his stuff? If he does, and the industry finds it out, he may safely count on a substantial career as an industrial power engineer.

BUSINESS IS BETTER

BUSINESS IS BETTER—not good, but definitely better. This is a condition which anybody may observe for himself in Pittsburgh or Cleveland or Boston. To this simple fact men apply a variety of theories. Some say the New Deal causes it. Some say it arrives in spite of the New Deal. Men call it this or that. Meanwhile we still have with us the good old motto, "Make Hay While the Sun Shines."

WHY RECORDS?

HOW CHECK COAL BILLS? Keep a record of coal consumption, as well as of tonnage purchased. How save the fuel purchased? Record steam generated and check it against coal burned. How save steam and electricity? Record and charge the consumption of each department. How make and protect an engineering reputation by *proving* the savings which records have made possible? Display these same records to owners and managers interested in cost reduction.

Is it any wonder that wise engineers refuse to operate without records?

PHONEY PHILOSOPHY

SOME CLAIM that scientific progress, which has made men skillful in growing food, weaving cloth and building transportation, forces men to go half starved, half clothed and on foot. It doesn't make sense, yet there is a real movement to halt science for the sake of humanity.

Beware the "pick and shovel" theory of prosperity wherein national well-being is measured by how hard people work and not by how much consumable goods they produce by their labors. The ultimate goal of such thinking is "Everybody employed—everybody poor." Beware of any plan that proposes to make America richer by cutting production or efficiency. Said one (kidder): "If hand tools are better than steam shovels for road work, let's use teaspoons and make a real job of it."

DON'T ASSUME

PROBABLY WE ENGINEERS assume too much. Theories are devised to make our lives easy. Eventually, we mistake these imaginary pictures for reality and forget to see what really happens.

Take the matter of boiling water, a prime job of power engineers. How many of us ever really watched the process? We imagine that steam forms on all points of a boiler tube. Does it? Stick an electric heating element into water and watch the surface closely. Heat a test tube of water, and see where the bubbles start. Turn to page 207.

What of it? We don't know, but we wonder whether, between James Watt and 1933, an engineer ever really watched a boiling tea kettle.

¢ PER 1,000 LB.

IN THE AVERAGE industrial plant, one unit cost stands above all others in importance. That is steam cost per thousand pounds. In it is buried the whole coal bill. It shows far more than skill (or lack of skill) in getting high evaporative efficiency. Unit steam cost is a combined rating of three things: Skill in selecting boiler-room equipment, skill in its operation, skill in coal selection.

In short, it comes pretty near being the complete measure of the engineer in charge.

FUTURE ENGINES

THE FUTURE MAY see heat engines unknown today. If so, what may they be? Today we have the steam engine, steam turbine, internal combustion engine. Less used are gas turbine, hot-air engine, "Still" engine (combination of internal combustion and steam), water-expansion engine.

At least one other possibility remains: An engine operated by the expansion and contraction of metal. Such an engine, apparently, has the same limiting efficiency as any other heat engine operated through the same temperature range. Mechanically, it eliminates all problems of tight pistons and stuffing boxes, but brings up other far greater difficulties. All in all, the metallic expansion engine would appear to be "not-so-hot," but nevertheless interesting for those who like to play with novel ideas.

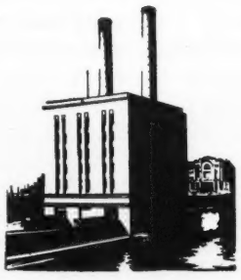
POWER STANDS FOR

1. Making power when it should be made
2. Buying power when it should be bought
3. Cheaper power through modern equipment
4. Easier financing of equipment purchases
5. Better use of by-product heat and power
6. Operating methods that save money
7. Less waste in transmission and application
8. Prevention of smoke, within reason

CHICAGO UNION STATION PLANT

SUPPLIES STEAM TO SEVEN

Six miles of overhead piping carry steam to seven customers from this modern 4-unit, chain-grate-fired plant. Economizers prove economical on annual load factor of 25 per cent. Electrical control permits 2-man operation



From the water

By THOMAS WILSON
Chicago, Ill.

REPLACING an older plant on the site of the new Chicago Post Office, the new central heating plant of Chicago Union Station Company went into operation in the winter of 1932. Customers include: Chicago Daily News Building (over a mile from the station), the new Post Office, U. S. Appraisor's stores buildings, Burlington freight terminal, Pennsylvania freight terminal and passenger coach yards, and the Union Station. Demand ranges from a normal requirement of 225,000 lb. of steam per hr. to a maximum of 340,000 lb.

Additional customers to the southward are expected to shift the load center closer to the new plant, which is about 2,300 ft. south and 1,000 ft. east of the old.

Steam is generated at 200 lb., and transmitted at this pressure through several miles of well-insulated steel piping, most of it 12- and 10-in. diameter. 8-in. wrought-iron pipe returns bring 60 per cent of the water back. Though the preliminary survey showed that power could be generated profitably as a by-product, other than strictly technical factors decided the issue, among them the additional investment, use of some 200-lb. pressure equipment from the old plant, and particularly questions of policy considered by the owners.

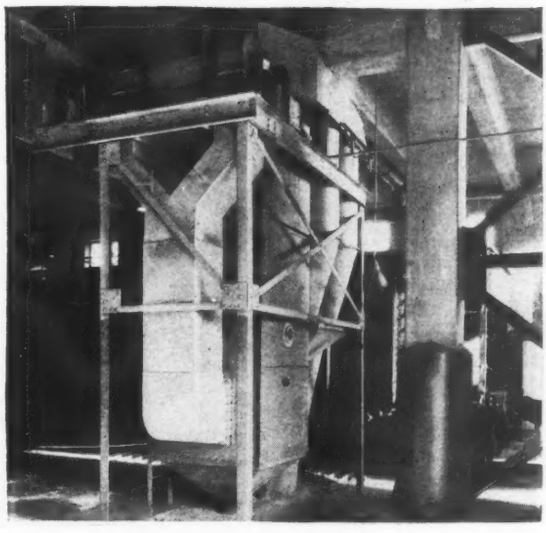
The plant had to be built above grade, hence reaches the unusual height of 110 ft. The boiler room floor had to be high enough to permit railway cars to run underneath, and three tracks at grade run through the building for delivery of coal and removal of ash. Heavy steelwork was required to support both building and equipment, including the stacks and an 1,800-ton overhead bunker. 100 x 115 ft., the building is roughly a cube set upon 32 concrete legs running down 68 ft. to rock.

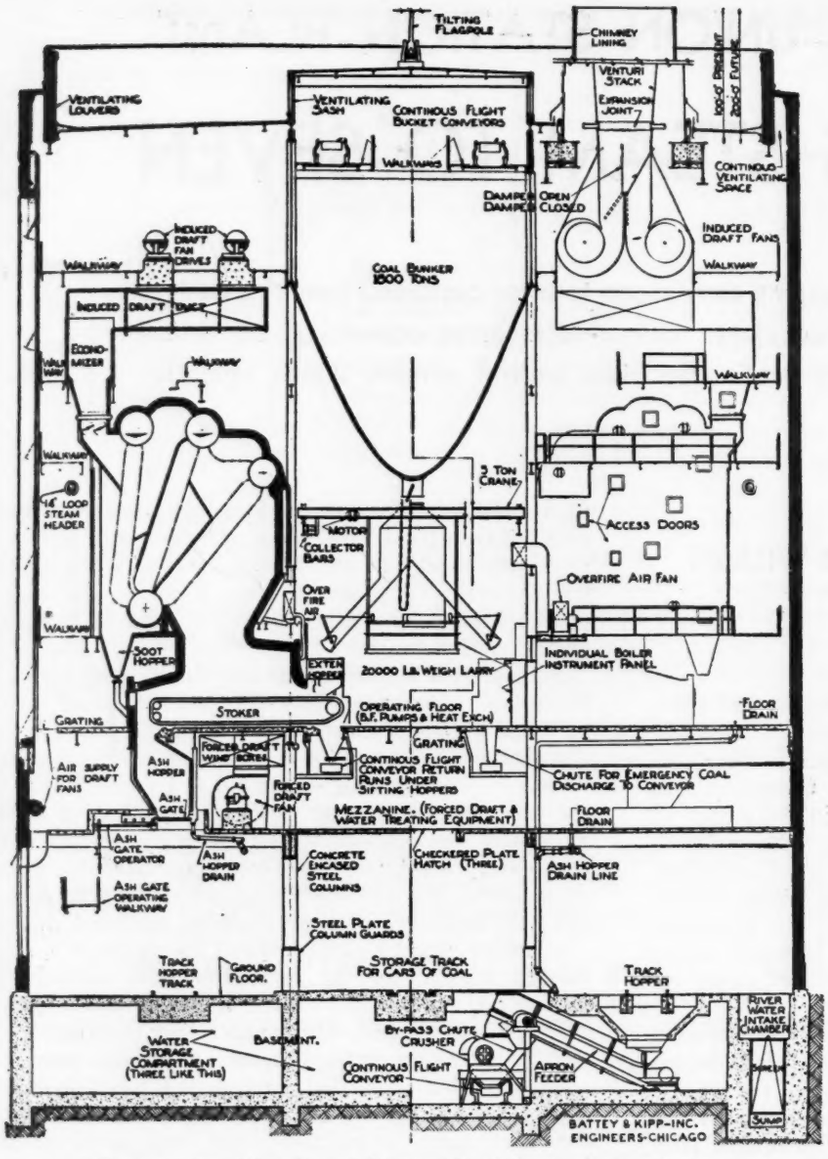
Four steam generators, each with maximum hourly steaming capacity of 140,000 lb. of dry saturated steam, operating at 200 lb. gage, supply present demand. At the maximum load of 340,000 lb. per hr., one spare unit is available. The arrangement is two boilers on each side of a central firing aisle. Each unit consists of a 12,010-sq. ft., 4-drum, bent-tube boiler equipped with 1,800 sq.ft. of bare side water walls with cast-iron protection blocks at the bottom, one 4,290-sq.ft. extended-surface economizer directly above the boiler uptake damper, and one 360-sq.ft. forced-draft chain-grate stoker.

Standard tile shiplap baffles give three passes through the tubes. Double spacing the front rows of tubes provided a slag screen. Boiler settings include front and rear arches with a 7½-ft. throat opening. Furnace volume is 4,100 cu.ft., giving a 3.4 to 1 ratio of heating surface, including water walls, to furnace volume. Front and side walls of the setting in the furnace, and first pass, except for that portion occupied by water walls, are of the air-cooled type, while the rear passes and rear walls are of the suspended insulated design. The entire settings are enclosed in panel-type steel casings, except for the rear stub walls behind the stokers and the portions of side walls above the drums. Here firebrick is used, with plastic boiler covering.

Admitted to the settings through adjustable dampers, air for cooling is carried through the side and front walls to an overfire-air fan, from which it is discharged through a series of nozzles in the front arch. It has been found that this method of introducing overfire

One of the two dust-collector units which pull coal dust from crusher, apron-conveyor discharge and stoker sifting hoppers





Cross-section (above) and firing aisle (below) of the plant. Coal, normally delivered by railway car, can in emergency be delivered by water

air is effective in aiding combustion as well as minimizing smoke. Steam nozzles are provided at each air nozzle and also in the front corners of the furnace. Through extensive experiments with these nozzles, the Chicago smoke prevention department has found that they are of great assistance in eliminating the smoke nuisance.

Installation of economizers or air heaters and the consequent induced draft requirements in a plant serving a heating load is often unwarranted, since annual load factor is but 20 to 25 per cent. Analysis showed in this instance, however, a material saving by the use of extended-surface counterflow economizers having a water outlet temperature of 290 deg. when operating at capacity with 13.5 per cent CO_2. Among the influencing factors was the possibility of using two stokers from the old plant. Increasing stoker length made them adequate when economizer surface was included. Other factors were excessive cost of large superimposed stacks necessary if no induced draft had been used and the nominal increase in building contents to house economizers and fans, as the center or coal-storage bay had to be high anyway.

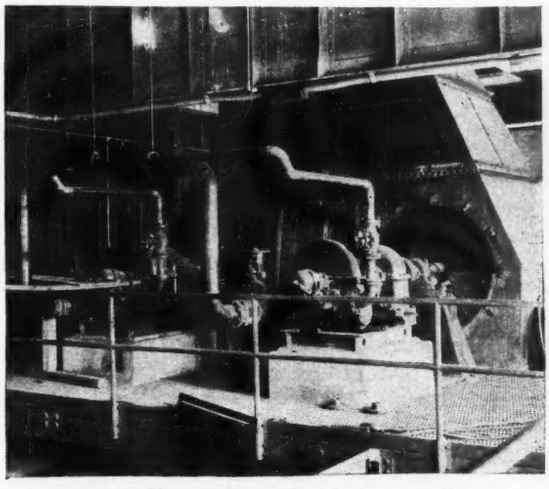
After passing through the economizers, gases of combustion are drawn through steel breechings to a twin fan between the boilers. Each fan is driven by a steam turbine through reduction gearing, and one also by a slip-ring motor on the opposite end of the fan shaft. Provisions are made to install motors on the other fans if desired later. Free-wheeling-couplings join fan and motor and fan and turbine, making it possible to change from turbine to motor drive, or vice versa, without shutting down. The fans may be operated in parallel or singly, either one serving either or both boilers. Gases leaving the fans pass through a venturi stack 30 ft. high and thence through the main stacks rising 100 ft. above the roof.

A complete system of electrically operated combustion control is provided whereby all fans, dampers and stoker speeds are automatically regulated and controlled with steam demand. Pushbuttons and switches are mounted on the boiler panels to allow individual operation of any control unit. The installation is standard except, as either one or both fans may draw the gases from either of its pair of boilers, the piping is arranged so that one combustion con-

trol unit operates a chronometer valve on the steam supply to both turbines, there being of course a shut-off valve at each turbine. When the motor is in use, speed also may be controlled from either boiler panel. Since, with a motor driving one fan and a turbine the other, speeds would be hard to synchronize, an auxiliary control is provided on the discharge side of each fan to keep these speeds equal automatically.

Coal-handling equipment has been entirely concealed. No yard storage is available, except for coal held temporarily in cars. Under these conditions, a duplicate system of continuous bucket conveyors was installed.

Coal is received through trackhoppers on the two outer tracks of the ground floor. It is then moved at right angles by apron feeders to continuous bucket conveyors. Motor-driven trippers discharge the coal along the bunker top. In returning, the conveyor runs horizontally to collect siftings from the hoppers in front



One of the twin-fan units during installation

of the stokers. These siftings are carried down to the basement, thence past the apron conveyors and up to the coal bunker. The coal bunker has a capacity of about 1,800 tons, at least four days supply.

To make the entire bunker storage available to any boiler, a motor-driven 10-ton weigh larry is installed above the firing aisle. Sixteen coal valves discharge coal from bunker to the cab-operated weigh larry. Interlocks between coal valves and larry are arranged so that the latter cannot be moved if the gate under which it is spotted is open, nor can a gate be opened until the larry is in position to receive coal. Coal dust is kept in as the coal drops from bunker to larry hopper by a telescopic frame of angles and 20-oz. canvas electrically operated by a thrustor. This must be in place before the valves can be opened.

Ashes are deposited in cast-iron, brick-lined ash hoppers having 14-hr. storage capacity. They are removed twice a day by railroad car. Ash gates are of the underslung type, with water seals and drains, operated by oil pressure from a central oil storage and pumping unit.

Quenching of the ash in the hoppers is effected by a mixture of city water and waste from the continuous blowdown system. After passing through the heat exchanger, blowdown water enters a tank on the second floor, from which it is withdrawn by a small pump and delivered to the quenchers.

About 40 per cent make-up water is required, and is obtained from city mains through an 8-in. pipe discharging into three separate concrete reservoirs in the basement. Water is kept at a predetermined level by means of tank valves, each reservoir being independently valved, both on the inlet and outlet side, to allow cleaning when desired. The three reservoirs have a combined capacity of 180,000 gal. below the overflow, or about 5 hr. supply at maximum demand. Water supply is also provided directly from the river, and the plant now ordinarily draws from this source.

Make-up water is pumped from reservoirs to auxiliary services such as hose valves, water-cooled bearings, etc., and also the sedimentation tank of the hot process lime and soda softener. Water supply to the softener passes through the continuous-blowdown heat exchanger and the vent condenser on the deaerating heater. Pumps for this purpose and the pump-and-receiver set for low-pressure and heating returns are in a basement pump room.

The 40,000-g.p.h. sedimentation tank extends through three stories of the auxiliary area, the valves and jet heater being accessible from the top or seventh floor and the blowdown from the fifth floor. Filtering equipment consists of three 9-ft., closed, pressure filters, and an 8-ft. diameter mixing tank. Three water-

(Continued on page 175)

Principal Equipment in Chicago Union Station Heating Plant

Boilers, 4, Connelly, bent-tube, 1,201 sq.ft. each	Foster Wheeler Corp.
Stokers, 2, Illinois, 360 sq.ft. each	Illinois Stoker Co.
2, Greene-Coxe, 360 sq.ft. each	Combustion Engineering Corp.
Water walls, 4 sets, 190 sq.ft.	Foster Wheeler Corp.
Air-cooled and insulated walls and arches, 2 sets	Bigelow-Liptak Corp.
2 sets	M. H. Detrick Co.
Boiler brick work	Nat'l Power Construction Co.
Economizers, 4, 4,290 sq.ft. each	Foster Wheeler Corp.
Induced-draft fans, 4, 100,000 c.f.m.	Prat Daniels Corp.
Induced-draft fan turbine drives, 4, geared type 110 hp.	General Electric Co.
Forced-draft fans, 4, 55,000 c.f.m.	American Blower Co.
Forced-draft fan drive turbines, 4, geared type, 30 hp.	Terry Steam Turbine Co.
Free-wheeling couplings, 6, Columbia	Engineers Specialty Co.
Over-fire fans, 4,800 c.f.m.	Clarage Fan Co.
Drive, 15-hp. motors	Allis-Chalmers Mfg. Co.
Boiler feed pumps	
1 centrifugal, 400 g.p.m., Cameron, Terry turbine drive	Ingersoll Rand Co.
1 centrifugal, 300 g.p.m. Murray turbine drive	American Steam Pump Co.
2 reciprocating, pot valve, 450 g.p.m.	Worthington Pump & Machinery Corp.
General service pumps	American Steam Pump Co.
	Chicago Pump Co.
Coal handling, continuous bucket and apron feeders, 2 each, 80 t/hr.	Link Belt Co.
Coal crusher, one, American, ring roll	Link Belt Co.
Dust-collecting system, two, 4,000 c.f.m. each	Prat-Daniel Corp.
Ash gates and pits	Allen-Sherman-Hoff Co.
Chimneys, breeching, duct work, boiler casing	Henry Pratt Co.
Water-treating equipment, hot process	Cochrane Corp.
Deaerating heater, 500,000 lb. per hr.	Cochrane Corp.
Combustion control, electric	Leeds & Northrup Co.
Boiler panels and boiler meters	Bailey Meter Co.
Air compressor, 150 c.f.m.	Ingersoll Rand Co.
Elevator, pushbutton	Westinghouse Elec. Elev. Co.
Piping	Robert Gordon
Valves, gate and globe	Lunkenheimer Co.
Non-return	Golden-Anderson Co.
Blowoff valves and expansion joints	Yarnall-Waring Co.
Flow meters, temperature records, CO_2 recorders	Brown Instrument Co.
Feed water regulators, Copes,	Northern Equipment Co.
Insulation	Asbestos & Magnesia Material Co.
Plumbing	E. B. Kaiser Co.
Tanks	Hamler Boiler & Tank Co.
Electrical work	Hatfield Electric Co.
Motors	Allis-Chalmers Mfg. Co.
Motor starters	Cutler-Hammer Inc.
Circuit breakers	I. T. E. Circuit Breaker Co.
Switchboard	General Electric Co.
Transformers, three 100 kva., one 50 kva.	Westinghouse Elect. & Mfg. Co.
Building structure	John Griffiths & Son Co.

HOT SPOTS

IN A TWO-YEAR OPERATING LOG

Things happen, good and bad, in the power plant. That is experience. It costs money to get and it is worth money to preserve it—on paper—for future guidance. Here are excerpts from the "experience log" of a large sugar refinery plant

AT THE BEGINNING of our boiler operation we suffered blade damage in our 400-lb. pressure mechanical-drive turbines which operate the auxiliaries, as well as in the 2,500-kw. power turbine. A considerable improvement in the quality of boiler output was effected by:

1. Reducing the alkalinity from 25 to 15-20 grains.
2. Lowering the water level (and column).
3. Moving superheater tubes so that they leave the drum above the steam-inlet tubes instead of below.
4. Providing baffles in No. 4 drum.
5. Anticipating as far as possible sudden fluctuations in demand for process steam.
6. Installation of steam separators.

"After these changes were made, we had no blade failures for 15 months until Dec. 12 last, when the turbine lost 7 blades, due presumably to a shot of water.

"The lowly setscrew caused us some trouble. On one occasion a setscrew came loose inside of the steam valve that controls the speed of the turbine driving the induced-draft fan. This little screw, which weighs about as much as a dime, ripped out a dozen turbine blades.

Boiler Tubes on a Rampage

"The upper tubes No. 18 deflected on both boilers, but there were no failures. In December, 1932, after about 10-months' use. the boiler builder replaced these. The No. 1 tubes likewise deflected and were replaced with alternate No. 0 tubes to serve as a slag screen.

"By June, 1933, both the No. 18 and the No. 0 tubes of both boilers deflected again, some as much as 6 in. Then June 13, one No. 18 failed in Boiler No. 1, and it cut a No. 17 just under it. Aug. 1, another pair failed in the same way.

"July 7, 1933, a No. 0 in Boiler No. 2 opened on top like a book, as shown in the photograph. The fire blew out and the explosion doors opened. In a day and a half, the boiler was returned to service. Oct. 13, another No. 10 tube opened in the same boiler and Oct. 17 a No. 0 in No. 1 boiler developed a blister and a small leak.

"The cracking of the No. 18 tubes we attributed to alternate slugs of water and steam. The water walls discharge through drum No. 2 and produce a volume of steam so large than it must seriously disturb the circulation of the 3-drum arrangement. The No. 0 tube failures were attributed to the same source. The upper part of these tubes were worn thin as if they had been sand-blasted. All of the tubes contained a little scale which may have contributed to the failure. The No. 0 tube scalé contained some iron, which may have been due to steam binding.

"To overcome these failures, ——— proposed an annular baffle in drum No. 2. The boiler builders installed these in both boilers in November and added a box at each end to cover some of the side-wall circulating tubes. Since this work was completed no tubes have deflected.

"Since November, the operation of the boilers has been comfortable. We are carrying a higher alkalinity in the water and the surfaces are clean, except for the soft white powder that we brush out of the economizer tubes at intervale of about two months.

"The shell of No. 1 induced-draft fan is wearing, and we have had to weld on some patches. We are considering the installation of a ——— cast-iron lining. The blades show no undue wear.

"The air-heater tubes are clean and free from rust. They require brushing at 3-month intervals.

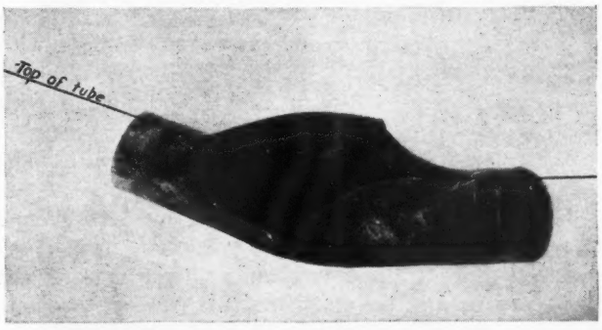
"On the advice of the valve builders, we used gate valves for throttles on the turbines. These do not remain tight, and the valve builders are now re-building the valves with new seats. We replaced some of the 3-in. gates with globes.

"Our flue-gas washing device, as designed from information received from ——— and ———, satisfies the neighbors. We have heard no complaints for a year. We now have three sprays. In the Summer time, while we are running heavy and the wind is towards town, we operate the two lower sprays and use the top one for occasional washing down. Under these conditions, moisture passes out of the stack and settles down on our roof.

"The sluice pipe under the stack was furnished by ———. While we awaited delivery, we made a temporary installation of steel pipe, using extra heavy for the bends. In less than one week, the metal was cut through. To avoid antagonizing the neighbors we kept it going by wrapping it with old inner tubes! The ——— pipe stands up very well. The first fittings wore out in a year. In some cases we were able to make repairs by filling the worn place with stellite welding rod. The original elbows did not have equal legs, which prevented reversing to change the wear. ——— have now changed this for our benefit. We are delivering the continuous blow-down water to the suction of the stack spray pumps to add alkalinity to the water.

"We are using 13,841-B.t.u. coal from ——— Mine, in Carolina-Marion County in West Virginia. This coal used to cost $2.95 per short ton delivered f.o.b. barges at our wharf. It raised last Fall to $3.30 and the "New Deal" added 56c. more Jan. 1.

This coal has a tendency to heat in the bunkers. In anticipation of this, we installed perforated pipes in the bottom for CO_2. We have had glowing coal in the bunkers, and with half a dozen bottles of CO_2 we have made this cold in a half hour's time. After a fire we draw down the bunker for cleaning, and on one occasion we removed a half ton of coke. We have a separate bunker for each boiler. The CO_2 extinguisher completely removes all uneasiness about fires.



A No. 0 tube opened on top like a book. The fire blew out and the explosion doors opened

"We have had no unusual experience with the pulverizers except as described in an item in the Log styled Believe it or not, dated Oct. 13, 1933, as follows:

A few days ago ——— was on the scale platform and by accident dropped a poker consisting of a $\frac{5}{8}$-in. round bar, 5 ft. long. The poker dropped through the grating towards the operating floor. Despite vigorous search, ——— was unable to find any trace of the bar. Four days later, No. 1 pulverizer on No. 1 boiler was shut down and opened for replacement of pegs, and lo, the lost bar was projecting down through the coal inlet, but had not come in contact with the rotor. The glass inspection door on the coal feeder was broken. The bar passed through the feeder opening like a spear, and, as the pulverizer did not explode, the hiding place of the bar was not suspected. The glass in the inspection door has now been replaced with steel."

CHICAGO STATION PLANT SELLS STEAM TO SEVEN

(Continued from page 173)

treating pumps are so piped that each can be used for back washing or for elevating treated water to the treated-water storage and surge tank. This storage tank also receives pumped returns.

From the storage tank, the mixture of clean condensate and treated water flows by gravity of the deaerating heater on the fourth floor—and thence to the boiler feed pumps on the third, or operating floor. Arrangements are made also to take raw water from the city water reservoirs to the pump suction header when desired.

All piping in the plant and the steam transmission lines are welded for sizes above 1 in., except where valves or specialties are required. Welding ells of $1\frac{1}{2}$ pipe diameters were used at all turns, except the long-radius bends on the boiler leads and the U-shaped expansion bends in the transmission lines. Tests at 400 lb. hydrostatic pressure did not reveal a single leak in the welded sections of the lines. The main steam header and the boiler feed header consist of loops around the outside of the four boilers, with sectionalizing valves between each take-off. This arrangement allows opportunity for segregating any section of the headers without a duplication of lines.

Results are indicated by this summary:

Evaporation per Hour, lb.	Per cent CO_2	Combined Efficiency, per cent	Quality of Steam, per cent	Total Draft Loss, In.
30,000	9.0	78.5	100.0	0.40
60,000	12.5	81.0	99.5	0.85
90,000	13.5	79.5	99.25	1.55
105,000	13.5	79.0	99.1	2.10
130,000	13.5	77.5	99.0	3.05

Nine men operate the plant through the three daily shifts. An engineer, stoker operator, two coal passers and a steam fitter who also takes care of the transmission lines make up the day shift. On the evening and night shifts, only two men are required.

The steam plant, including the structure and the layout of the equipment, as well as the new steam and return transmission lines, were designed and the installation supervised by Battey & Kipp, Inc., consulting engineers of Chicago. The work was done under the direction of O. H. Frick, general manager, and C. E. Cox, assistant chief engineer of the Chicago Union Station Company, while technical details also were supervised by the mechanical departments of the three proprietary railroads. Exterior building treatment was by Graham, Anderson, Probst & White.

QUARTER ELBOWS FOR CORNERS

Beer-cooling tank 30 ft. long, 12 ft. wide and 7 ft. deep, fabricated from $\frac{3}{8}$-in. Byers wrought iron plates by Otto Meyer Mfg. Co., Brooklyn, N. Y., for Liebmann Breweries, Inc., Brooklyn. The tank is of electric-welded construction, and particularly interesting from the standpoint of design are the means used to secure the rounded edges and corners. Instead of flanging the plates, quarter sections of 10 in. 41 lb. wrought iron pipe were used for the edges and a section of welding elbow was used for each corner.

POWER SAVINGS SAVE OLD

By M. A. BUETTELL
Engineer, Dodge Mfg. Corp.
Mishawaka, Ind.

Grain elevators require but little heating steam, therefore are not adapted to economical steam-power generation. Conversion to synchronous-motor drives makes power cost less than fuel

"MODERNIZE!" cry the hard-hit capital-goods industries. "But do it wisely," should be added. Five years ago, expansion was the popular theme. The excesses of that era are well known. We Americans swing from one extreme to the other, so now, having learned the errors of unbridled expansion, we swing to the other extreme and cut out even essential modernization. Today, millions of dollars are wasted each year by obsolete equipment, millions of dollars which are charged against the products of American industry, dollars which could earn a profit if spent to replace that obsolete equipment with modern types.

This story of Rosenbaum Grain Corporation, Chicago, Ill., owner and operator of several large grain elevators, is worthy of more than a casual glance. Some of these elevators, built before 1900, were equipped with steam-engine drives.

In modern grain elevators, concrete bins are filled and emptied by elevators and conveyors having individual motor drives. In the older elevators, a steam engine drives a lineshaft system through one or several rope drives. Costs of handling grain in these older structures kept climbing. Coal costs mounted, engine and boiler repairs increased, wages for engineers and firemen rose. Boiler codes demanded constantly reduced steam pressures for boilers more than 20 years old. A grain elevator requires very little steam for heating, therefore in general is not adapted to economical power generation in an isolated plant. Newer elevators began to gain a distinct operating-cost advantage.

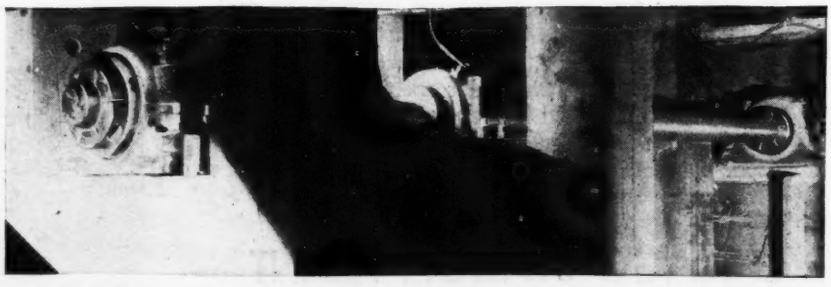
The management decided to make a study of modernizing driving equipment in its older elevators and selected the 35-year-old Irondale elevator in Chicago. The original drive was from a large steam engine through an American-system rope drive to a jackshaft and from the jackshaft through a vertical rope drive to the main lineshaft over the storage bins. All cleaning equipment and elevators and conveyors were driven from this centralized lineshaft.

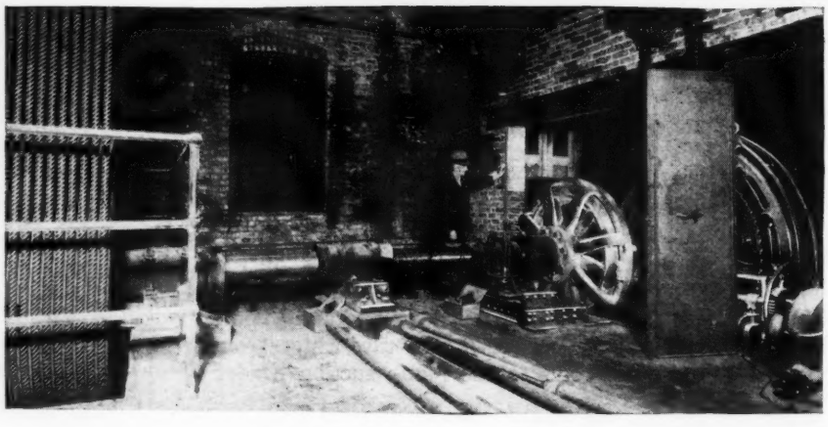
The report of the consulting engineer outlined five different plans to modernize this drive to reduce grain-handling costs.

1. Replace present steam engine and boilers with modern types.
2. Replace present steam engine and boilers with modern diesel engine.
3. Replace centralized mechanical drive with individual electric motors.
4. Divide centralized mechanical drive into groups of machines, each group driven by electric motor.
5. Retain centralized mechanical drive and replace steam engine and boilers with one large synchronous motor.

Advantages and disadvantages of each drive were carefully tabulated to obtain the lowest dollar-and-cents over-all operating cost. Centralized mechanical drive operated by a synchronous motor was selected. The main points favoring this drive over the other possibilities were: Low capital outlay, low operating cost, and least interruption of operations to make the change. This plan kept the good features of the existing drive and added the best in modern power layout.

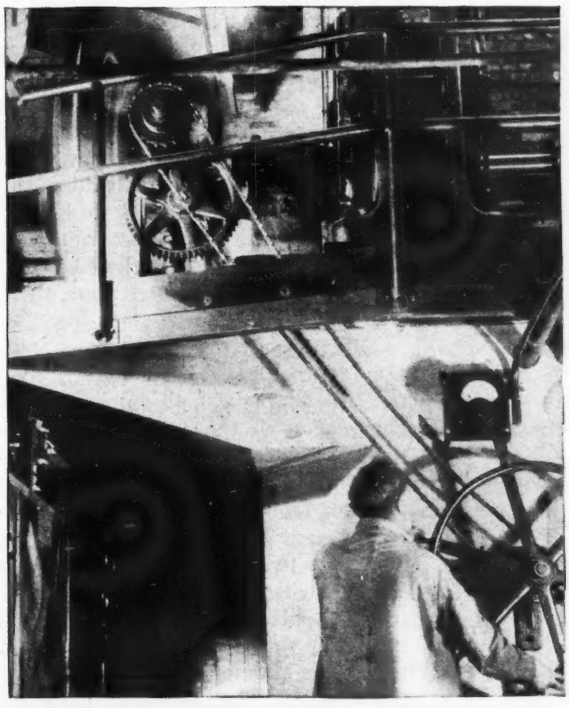
Bottom—Friction clutch connects 500-hp. synchronous motor to lineshaft originally driven by steam engine. Below—Roller bearing on lineshaft driven by 300-hp. synchronous motor

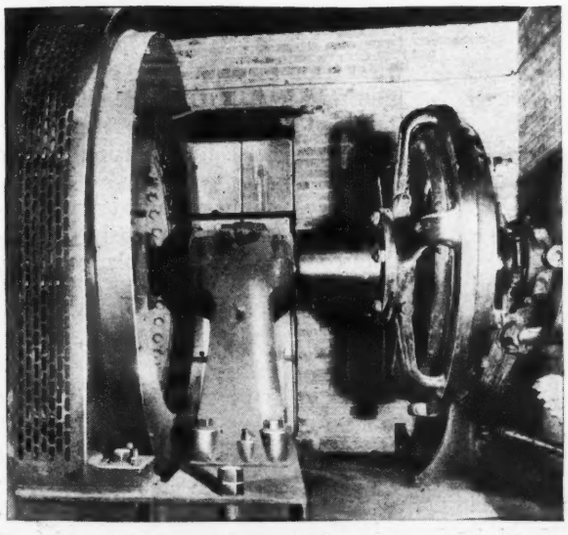




GRAIN ELEVATORS

A SAMPLE OF SENSIBLE MODERNIZATION





Top—Clutch control wheel and ammeter for regulating current demand when starting load with synchronous motor. Above—Friction clutch close-couples 250-hp. synchronous motor to line-shaft

When the steam engine was used, the flywheel drove a jackshaft on the main floor of the elevator through a rope drive at 109 r.p.m. This rope drive was eliminated, and a 500-hp. synchronous motor was selected to run at the same speed as the jackshaft.

Torque characteristics of the new prime mover were different than those for the engine. The steam engine developed a high starting torque that could be readily controlled to start the heavy static-friction and inertia load of the elevator equipment. To keep down starting current peaks, a synchronous motor with normal starting torque was selected and a disk-type friction-clutch used to connect it to the jackshaft. This clutch allows the motor to start without load, after which its full pull-out torque is available to start the load by engaging the clutch. It also permits the operator to control motor current during load starting, to prevent serious power-line disurbances.

Simplicity of the new drive permits its operation with only ordinary mechanical help around the elevator. To guard against the high line current when starting, an ammeter is located adjacent to the hand-wheel of the clutch shifter. On the ammeter dial is marked a maximum-load point. When starting the load, the operator engages the clutch by rotating the shifter hand-wheel at a rate that keeps the ammeter pointer from going beyond the maximum-load point. Some of the results obtained with the modernized drive are:

1. Electric current costs less than did coal on the former drive.
2. Greatly increased efficiency.
3. High power factor for electric load because of synchronous motor.
4. Low depreciation rate with simplified drive.
5. Reduction in maintenance cost over steam drive.
6. Elimination of steam-plant labor cost.

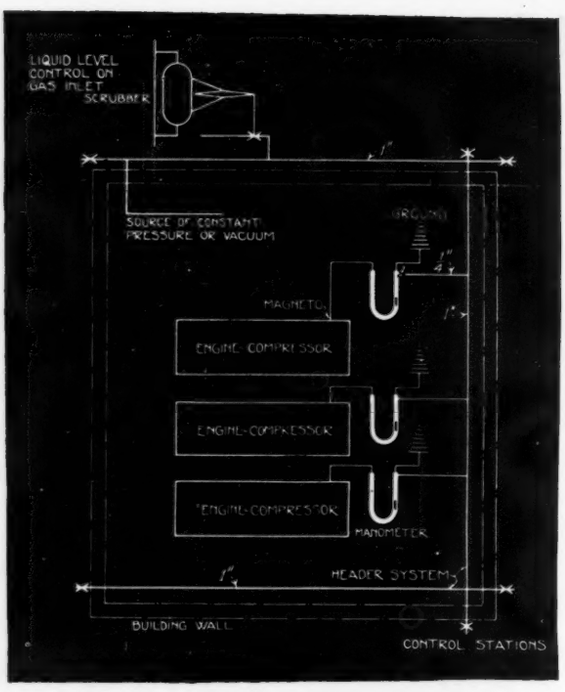
Over-all savings effected by this modernization will return the investment in less than three years.

Profitable results of this drive survey caused Rosenbaum Grain Corporation to study operations of its other elevators. In Chicago, two other elevators were modernized in much the same way as the Irondale unit. Rearrangement and replacement of some existing parts of the drives were necessary, such as a change from plain to roller bearings on lineshafts, but the combined synchronous motor and clutch drive was used.

Others Accept Idea

Other elevator operators in the Chicago area have been quick to accept the idea of modernizing existing equipment through the use of the highly efficient synchronous motor and clutch drive.

The Irondale case is typical of the sensible attitude in many plants towards modernizing the equipment which keeps the machinery running. Less spectacular and impressive than the tremendous expansion of five years ago, this modest expenditure for capital goods is on more sure ground. It pays its way. As expressed by the management of these elevators, it is not necessary to scrap existing equipment to modernize. Parts are replaced only where new ones will pay a profit; those parts not profitable to replace are retained.



PULL the SWITCH

TO SHUT DOWN A GAS-ENGINE COMPRESSOR PLANT IN EMERGENCY

By F. L. KALLAM
Industrial Engineers, Inc.
Los Angeles, Calif.

IN ONE gas-engine, gas-compressor plant, an earthquake shifted the absorbers enough to break the gas connections, requiring an immediate shutdown. The operator attempted to do it by closing the main fuel valve outside the building, then went into the building and closed each engine throttle. Even though at least two minutes passed between closing of the main valve and of the last throttle, *all engines continued to run* until their throttle valves were closed.

In another plant, a compressor head was ruptured by excessive liquid in the cylinder. The operator immediately closed the master fuel valve, but when a disastrous explosion occurred at least a minute later, the engines are believed to have been running.

These two instances prove that closing the main fuel valve doesn't shut down the engines quickly enough to prevent explosions. The ignition system works as long as the engines run, creating an explosion hazard.

Almost all gas-engine plants have fuel headers under pressure, with individual regulators reducing this pressure to the engines. Thus there is enough fuel stored in the header to run the engines for several minutes after the main valve is closed.

In some plants, combustion air is taken from within the building. If this air contains gas or vapors, the engines might continue to run on the mixture for a short time, even with the fuel valves closed. For ordinary dry gas, a mixture as low as 5 to 12 per cent of gas by volume in air is explosive; for gasoline vapors, it may be as low as 1.5 to 6 per cent.

These data prove it essential to guarantee safety by grounding the ignition systems for emergency stops. Tests show that engines under full load will stop in from 8 to 12 sec. when the ignition is cut out, this period being caused by flywheel momentum. But during that time, there is no explosion hazard.

Several systems of remote ignition control have been tried. Systems that tap the high-tension secondary cables of the magnetos are difficult to keep in operation. Interference between magnetos causes trouble from induced currents between parallel cables from the magnetos to multipole switches. Also the condenser effect of long high-tension leads and leakage through the insulation may cause ignition failures.

From a practical standpoint, magnetos should be short-circuited on the low-tension side to kill the ignition. Such systems require ground wires run through long conduits to multipole switches outside the building, and difficulties are similar to those that cause high-tension system failures.

The system diagrammed stops several engines simultaneously by remote control, and is simple, compact, reliable, and low in first and maintenance costs. A 1-in. pipe carries either constant air pressure or vacuum, as desired. At each engine, a $\frac{1}{4}$-in. line runs to an insulated mercury manometer next to the magneto. One terminal of the manometer is grounded, the other, a very short one, runs to the low-tension side of the magneto. From the 1-in. control header, connections are made to several emergency stations, inside and outside the building. Each carries a quick-opening valve. Normally, mercury in the manometers is held in contact with one terminal only by means of the pressure or vacuum. When a quick-acting valve is opened, the mercury balances, makes contact, grounds the magnetos and closes down the engines.

Gas Scrubber Emergency Station

One station may be operated by a float in the gas scrubber. Should liquid in the scrubber accumulate beyond the safe operating point, the float automatically shuts down the plant.

FIREBOX BOILER FIRED BY CHAIN-GRATE STOKER

Special arch solves problem. Arch refractory has been found to stand up without cooling, no trouble has been experienced with ignition and boilers can be brought out of bank to 5 lb. pressure in 40 min. on coldest days

HEATING plants of two new school buildings at Freeport, Long Island, N. Y., are of particular interest because of the Illinois chain-grade stokers installed under Heggie-Simplex, low-pressure, heating boilers designed to burn No. 3 barley anthracite. In the Columbus Ave. School, two 2,000-sq.ft. boilers serve a heating system of 32,000 sq.ft. of equivalent direct radiation. The Cleveland Ave. School is smaller, having a heating system of 17,000 sq.ft. radiation served by two 930-sq.ft. boilers. Except for size, boiler and stoker installations are practically identical. Consequently only a cross-section of the larger installation is shown.

When first put in operation, arch *A* had not been provided. Preliminary operation without the arch disclosed that proper combustion was not being secured and that ignition was too slow.

After some experimenting by Walter C. Hawkins, Engineer and Supt. of School Buildings, a temporary arch was tried in about the position shown by *A*. Test runs showed greatly improved combustion and in addition increased firing rates were found possible. It was further found that the arch refractory would stand up under the furnace conditions to which it was subjected even though no provision for cooling was provided. Installation of stokers also resulted in the elimination of a fireman in each building.

The permanent arch is shown at *A*. At its front end it is only 22 in. above the grate, 14 in. above the grate at the rear end and 3 ft. 7 in. long. Since its installation, no trouble has been experienced with ignition and the boilers have been brought out of bank to 5 lb. pressure in 40 min. on the coldest day. For overnight periods, the fires are banked by running the stoker for 15 to 20 min. after the fan is shut down, putting in a bed of green coal 3 to 4 ft. long. To bank from Friday night to Monday morning, several shovelfuls of coal have to be put in through the side door.

Although each boiler was designed to carry only two-thirds of the heating load, it has been necessary to operate only one boiler even in the coldest weather. CO_2 has averaged slightly better than 11 per cent. Satisfactory test runs have been made with anthracite screenings and coke breeze and it appears that most of the available solid fuels can be burned.

Variation in weather conditions are readily compensated for by operating zone dampers which allow the operator to use longer or shorter fire as needed.

Steam pressure is maintained at 5 lb. by automatic control which starts and stops the fan and stoker as required. The stack damper is interlocked with the fan so that it opens 10 sec. before the fan starts and stays open 10 sec. after the fan stops.

After one full year of operation, the cost of steam has been computed to be $3.60 per 1,000 sq.ft. of radiation for the season. Freeport had been heating its school buildings for a number of years at an average cost of about $3.75 per 1,000 sq.ft. of radiation.

Kopf & Sears, New York, N. Y., were the engineers for the new buildings.

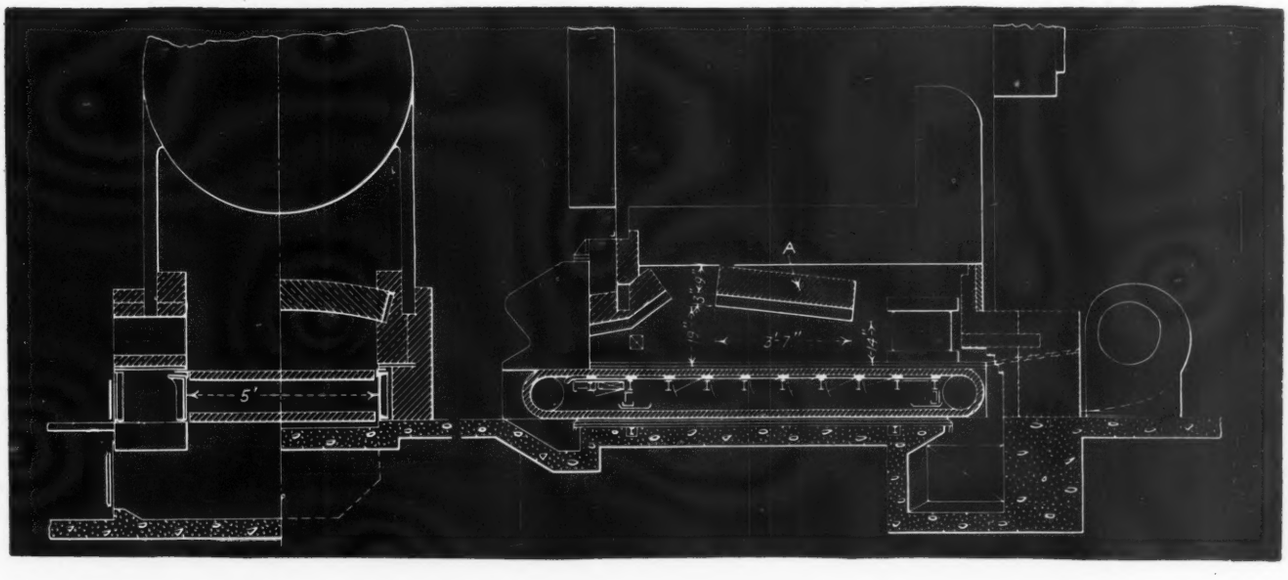


Fig. 1 — Pressure oil pump on crosshead is connected to bearing pin

ALTERS LUBRICATION SYSTEM FOR GAS-COMPRESSOR CROSSHEAD PINS

By EZRA K. NICHOLSON
Cleveland, Ohio

Changing from gravity feed to pressure lubrication on several heavy-duty units reduced maintenance and increased reliability

WHEN a process operates continuously, it is highly important that units which supply it do not fail. Lubrication failures occurred on several high-pressure gas compressors, at duPont Company's Belle Works, serving a high-pressure synthesis process sensitive to sudden changes in gas flow. Resulting high maintenance costs led to the investigation described in the February number of *Power* (pages 74-75). That article discussed oil-groove changes in crankshaft and crankpin bearings; this one describes alterations to the connecting-rod pin lubrication system.

The crosshead pins of these compressors are 10 in. in diameter, with bearings 12 in. long. Bearing arrangement is shown in Fig. 2. Projected area of the head-end portion of the bearing is 120 sq.in. and of the crank-end 102 sq.in. These bearings were formerly lubricated from an oil boat on the crosshead, as in Fig. 3. A short longitudinal oil trough in the top of the connecting-rod eye supplied oil to the bearing through holes drilled in the top of the connecting rod and bearing. Bearings were supplied with conventional cross grooves, and the tops and bottoms of the crosshead pins were slightly flattened to provide reservoirs for oil.

Total pressures on the crosshead pins were essentially the same as those on the crank pins, so the total pressure diagrams that had been made for the crank pins were also used for the crosshead pins.

Since the crosshead bearing motion on the pin was small, due to the 9 to 1 ratio of connecting-rod length to radius of crank circle, it was not possible to rely upon rotation of the shaft to maintain an oil film between the pin and the bearing, as in the cases of the main and crank bearings.

On the left-hand side of the compressor the pressure was always on the crank-end portion of the bearing, and it varied from 440 to 1,830 lb. per sq.in. With no relief from loading on this side of the bearing, it was impossible for a gravity feed to supply a film of oil between pin and bearing. To overcome this difficulty, the crosshead pin was drilled and grooved as in Fig. 4, and oil grooving was omitted from the crank-end portion of the bearing. A conventional slip-tube oiler was considered for use here, but was not used because of construction limitations and because the oil pressure required was higher than that in the oiling system. The arrangement used, Fig. 1, has several desirable features.

The normal outlet of the oil boat was plugged and a hole was tapped into its side for the suction pipe to an oil pump, which was mounted on a special bracket attached to the crosshead. The discharge connection of the pump was piped directly to the oil hole in the crosshead-pin center. A tee was provided in this line for a pressure gage. A pump-plunger driving pin was attached to the connecting rod, where it has a vertical motion of about 3 in. A connecting link was provided between driving pin and pump plunger. Splash inside the compressor oil guard was relied upon to lubricate the oil-pump driving pins.

No Adjustment

The impossibility of adjusting the pump packing while the compressor was in operation caused some concern before the pump was tested. However, it was

found that this packing very seldom required adjustment. A small headless setscrew was provided to prevent the packing nut from working loose.

During operation, when sufficient oil was fed into the left-hand side oil boat to maintain a constant level, a pressure gage attached to the oil-pump discharge line indicated approximately 1,800 lb. per sq.in. Close agreement of this pressure with unit bearing pressure indicated that an oil film between pin and bearing was maintained. This was confirmed by a rapidly diminishing pressure when insufficient oil was fed into the boat.

Before the oil pump was installed for supplying oil to the left-hand side crosshead bearing, it was impossible to operate this bearing more than an hour without excessive heating and "pulling." After installing the oil pump, continuous operation of this bearing was obtained with a temperature somewhat lower than that which would normally be expected. An excessively high maintenance cost and an intolerable operating limitation were eliminated by the use of this additional pump.

Right-hand Side of Units

On the right-hand side of the compressors, pressure on head-end portion of the crosshead bearing varied from zero to 710 lb. per sq.in. while on the crank end it varied from zero to 2,100 lb. Operation of this bearing was reasonably satisfactory. It was found, however, that by eliminating oil grooving from the lower part of the head-end portion, all oil grooving from the crank-end portion, and introducing the oil between pin and crank-end portion of the bearing during the period of greatest pressure at this point, the number of adjustments required were reduced and double the normal life of these bearings was obtaind. A pump arrangement similar to that previously described was employed for this purpose, but the bottom of the oil boat was not plugged. A portion of the oil fed into the boat thus followed the original gravity channels to lubricate the head-end portion of the bearing.

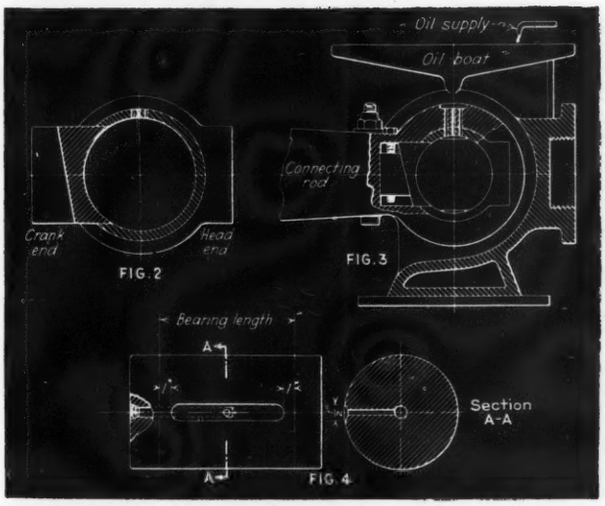


Fig. 2—Compressor crosshead-pin bearing. Fig. 3—Crosshead bearing, showing original lubrication method Fig. 4—Crosshead pin, showing new lubrication arrangement

Smart Guys, These Engineers!

By JOHN TALBOT

"GIVE a plant engineer a piece of pipe and a wrench and he'll build you a boiler plant." An old saying, but nevertheless a true one, for if you're wanting just plain ingenuity and what we Hoosiers used to call "horse sense," you'll find it in the boiler house.

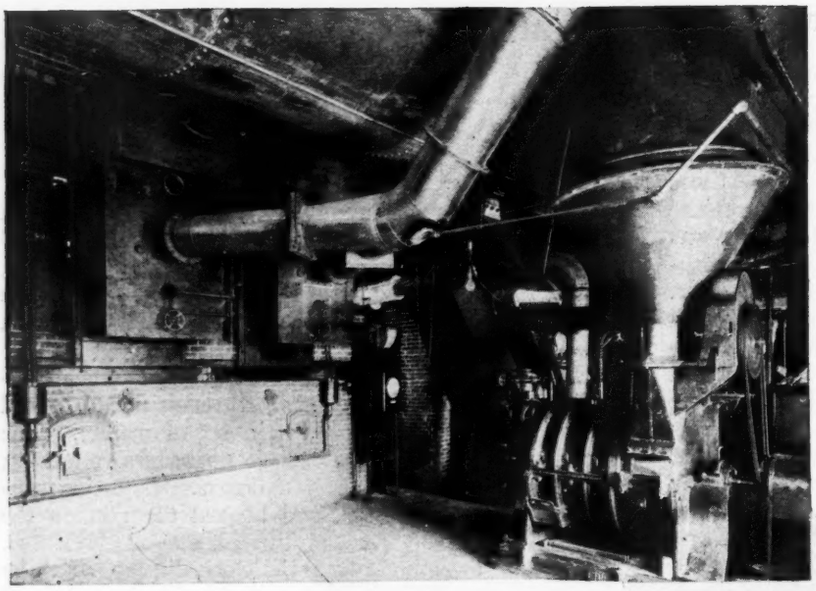
Maybe this will show what I mean: The chief engineer of a building plant had requisitioned, asked about, and finally begged for, a set of meters. The building was well in the red, so no meters came. In desperation, he bought a half dozen self-starting synchronous electric clocks, and hooked them in on the lines to units that operated intermittently. Of course, every time the unit started, the clock did too, so all he had to do was to set the hands at 12 o'clock at the end of the shift or the end of the day, and he knew exactly how long the unit had operated in a given period.

Here's another: It gets cold in Pittsburgh, and as water pipes will, they freeze every once in a while. A Westinghouse engineer recently had frozen pipes in a place where a blowtorch wouldn't work—too near woodwork and too much danger of fire. So he sent one of the boys for his wife's electric heating pad and fan heater. Together they thawed pipes in jig time.

In thawing pipes underground, G.E. engineers used an arc-welding generator for current. Its leads are connected to opposite ends of the frozen pipe. 250 amp. thaws 300 ft. of $\frac{3}{4}$-in. pipe in 3-10 min., 500 amp. thaws 100 ft. of 3-in. pipe in an hour. Voltages usually run 10-50.

And another: We were installing an accumulator for a hydraulic press system. Piston and cylinder were 23 ft. long, and together weighed about 75 tons. Our equipment included a 15-ton crane only, so we hired a railroad wrecker and crew. After a morning's juggling, they succeeded in dropping the assembly across one corner of the foundation, messing the stuffing box gland. But wrecking trains in those days rented for $100 an hour, so we went at it again. The piston and cylinder were finally set, but we still had the problem of the gland, and 23 ft. up in the air too! When we got a staging up, we found the gland sprung to an oval, and when we tried to wedge it out, we simply pulled the flange off the bushing. There we were, with no hydraulic equipment set nor piping connected, and a piston and bushing jammed in the cylinder. After the steam engineer stood around with his pipe in his face for a while, he offered the services of his boiler-feed pump. With a little pipe fitting, it was ready. Then he simply started the pump and fed the accumulator instead of the boiler. When the pressure got high enough, up popped the piston, out popped the bushing.

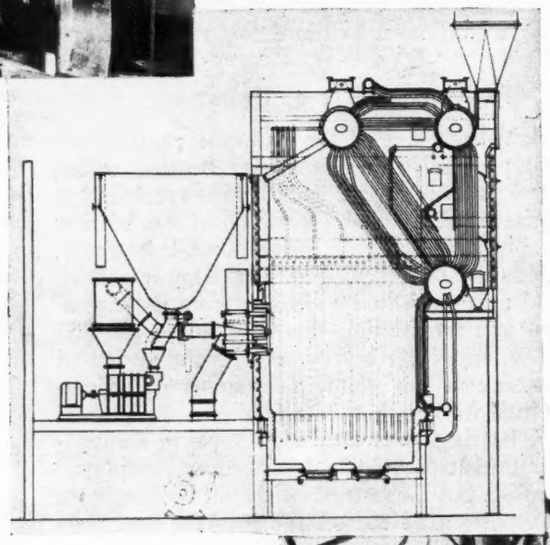
And again: We were troubled with a need for drinking water. City water, even when chlorinated, wasn't fit to drink, but good well water was available, and a few feet down at that. So the steam engineer rigged up a long water pipe and sunk the pipe with city water pressure, then ran a small compressed air line down it for an air lift. And there we were with drinking water.



FRANCIS A. WESTBROOK, M.E.
Brooklyn, N. Y.

tells the story of the new pulverized-fuel boiler that replaced six old units at the Endicott, N.Y., plant of Endicott-Johnson Co., shoe manufacturers. It will supply 72,000 lb. of steam per hr. at 250 lb.

1 REPLACES 6



SIMPLICITY was the keynote in designing the new 72,000-lb. per hr. steam plant of Endicott-Johnson Co. at Endicott, N. Y., because it must operate for long periods without shutdown.

The original installation consisted of two boiler houses, one containing six 4,000-sq. ft., straight-tube boilers fired with multiple-retort, underfeed stokers; the other two 5,200-sq.ft. B. & W. boilers fired with Erie City Unitype pulverizers. The furnace is of the solid-wall, flat-bottom type, and secondary air for combustion is induced by natural draft, with the pulverized fuel fired vertically.

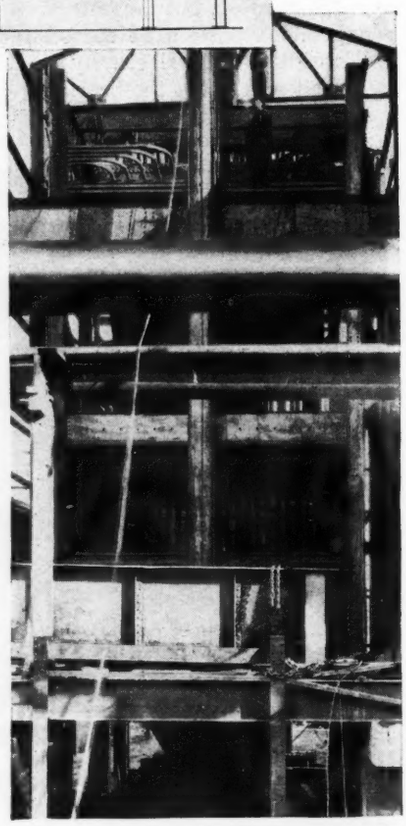
The pulverizer plant, one of the earliest of its type installed, still operates up to 200 per cent of boiler rating. When it was realized that a large saving could be made by replacing the six old 4,000-sq.ft. boilers with one new one to operate at a high continuous rating, pulverized fuel firing was selected because of the company's greater success with it. More efficient handling of coal, reduced operating labor and maintenance and increased boiler and furnace efficiency were expected from the new unit. The old plant could be held as standby, and certainly no lower prices than those now prevailing could be expected.

The new equipment consists of one 8,070-sq.ft., 3-drum, bent-tube boiler, built for 250-lb. working pressure, with Erie City basket-type water-cooled furnace, water-cooled bridge wall and ash hopper with refractory-lined ash gates and lower housing. An Erie City Unitype pulverizer is used, with a forced-draft fan. Convection-type superheaters for 100 deg. superheat and Diamond Valv-in-Head soot blowers are installed. Boiler settings are steel cased, made in sections to provide easy access for repairs.

A stack, 84 in. in diameter and 160 ft. high, is supported on top of the boiler.

Boiler house, coal bunker and coal-handling equipment of the other pulverized-fuel unit have been extended to take care of the new one. To make this change, it was necessary to run a 10-in. steam line across the Erie main line tracks. The new unit will operate up to about 300 per cent rating, or 72,000 lb of steam per hr. continuously, the maximum which the old boilers could be relied upon to produce. Some efficiency was sacrified by not installing air heaters or economizers, but these were left out in order to maintain maximum simplicity and minimum outage. Space was left, however, for this equipment if it becomes desirable later.

Forced-draft firing permits boiler operation at high CO_2, and steam flow charts show 60,000 lb. per hr. average for 24 hr., with about 580 deg. exit temperature. Copes feed-water regulator, Bailey meters and Dart gage panel are part of the boiler equipment. Control is by hand.



During Construction

IMPROVED POWER PLANT EQUIPMENT AND OPERATION

SAVE VIRGINIA $73,000

IN 1925, the State of Virginia spent $331,133 on coal used in state institutional power plants. The average price at the mine was $1.70 per ton, plus $2.50 per ton for freight. Under the supervision of Adolph Wagner, operations and equipment in eleven of the institutional power plants have been improved, resulting in a 29 per cent reduction in fuel used. In all cases, the savings paid for the cost of improvements in less than two years.

This is typical of what a few states have done with their power plants and what many more could do. It has in this case been accomplished by attention to details and by making a number of small savings that quickly add up to a substantial sum.

The campaign to reduce state fuel bills started with a questionnaire sent to all institutions, requesting this information:

(a) Population, (b) Type of heating system, (c) Square feet of radiation, (d) Boiler and engine room equipment, (e) Tons of coal used per day, month, year, and name of mine, (f) Pounds of ash removed per day, month and year, (g) Type of scale for weighing coal and ash, (h) Gallons and temperature of feed water.

In all cases, only part of the information called for was received. None of the plants kept a record of the daily coal consumption, feed water evaporated or ash disposed of. A total lack of scales and instruments was disclosed.

Starting with the larger institutional plants, it was found that average evaporation of from 6 to 7 lb. was being obtained. Boilers were hand-fired. Steam pressure was controlled in some instances by opening the fire door, and closing the ash doors. Some of the plants did not have any feed-water heaters or soot blowers. Much of the equipment was obsolete. Boiler settings were too low, often being only 4.5 ft. from floor to boiler and 7 ft. to the lower tubes of water-tube boilers.

Underfeed stokers were placed under boilers that were found in good condition. The stokers were pitted, so that a furnace height of not less than 7 ft. was obtained. In two plants, new boilers and stokers were installed. Feed-water heaters, feed-water regulators, draft gages, control equipment and steam flowmeters were installed. Two plants were entirely abandoned, and new ones built. Some of the plants were equipped with CO_2 meters, and it is the intention to install these instruments in all larger plants.

A considerable amount of steam was being lost by condensation in poorly insulated heating distribution mains under buildings and underground. At one institution, underground distribution lines were insulated with air cell and laid in terra cotta. Ground water had easy access to the steam line and ruined the insulation. A new distribution system was installed in concrete ducts insulated with sponge felt and water-proof covering. The following winter, steam consumption was cut in half.

Personnel was impressed with the idea of saving all possible B.t.u.'s, and exhaust from auxiliaries that formerly was wasted is now used to heat feed water and domestic and laundry water. Five of the plants generate electric energy for light and power. Exhaust steam is utilized for heating and hot water. During the summer months, there is considerable exhaust steam wasted. This waste was greatly decreased by replacing 30-year-old engine-generators having water rates of 100 lb. per kw. with modern uniflow engine-generators.

Coal is now purchased on specifications. It is tested under actual firing conditions before the contract is closed. The cost per thousand pounds of steam, including the effect on furnace lining, is used in determining coal purchased, not quoted price.

A system of daily records has been introduced and will eventually be used in all plants. Monthly records are forwarded to the supervisor's office, and an average monthly evaporation in plants having instruments is 10 lb. of steam per pound of coal fired.

There are altogether 25 institutions wholly or partially state-supported. Virginia Polytechnic Institute has an up-to-date plant, but as electric current is supplied to the town of Blacksburg, this plant has not been included in the table showing comparative cost of fuel before and after improvements were made in equipment and operation. In addition to the institutions listed new boilers, stokers, deaerating heaters and instruments were installed last September in the plant of the Eastern State Hospital, Williamsburg, Va. This leaves only five plants to be improved. Remaining institutional plants are small, three being equipped with downdraft boilers showing an evaporation of 10 lb..

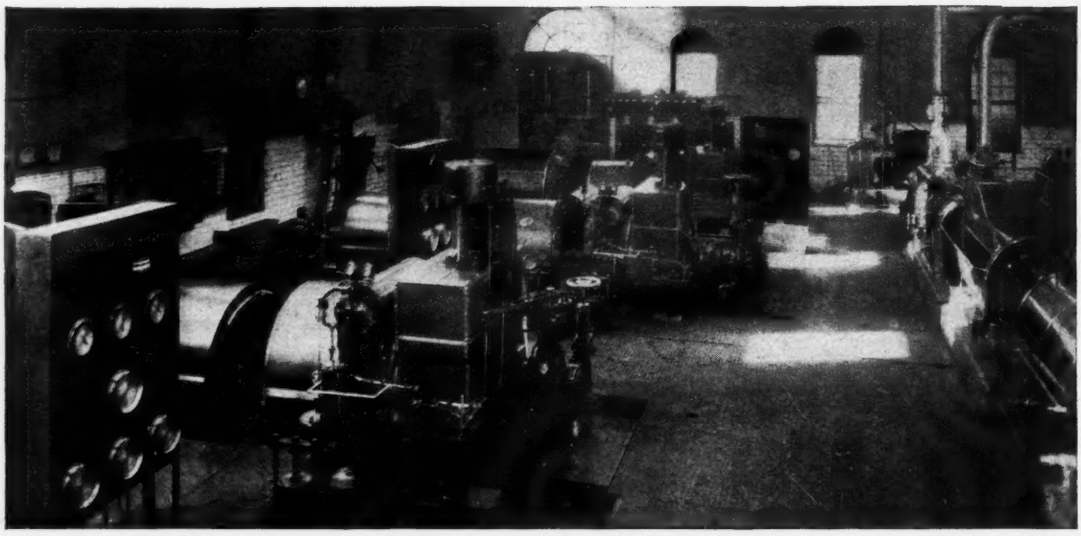
Zone control has been installed in the heating systems at two institutions, and will be extended to others as funds are available. Power plants in Virginia Polytechnic Institute, College of William and Mary, and the State Capitol are operated by three engineers, and three firemen. All other institutions have only one engineer and two or three firemen. The average labor cost in the latter plants is $3,300 to $4,500. In calculating the two right-hand columns of the table below, weather differences were considered.

Comparative Cost of Fuel Before and After Improvements in Equipment and Operation

Institution	Year Improvements were made	Year 1926-1927: Coal Consumed, Tons	Year 1926-1927: Expenditure, Dollars	Year 1926-1927: Heating Load, Square feet of Radiation	Year 1932-1933: Coal Consumed, Tons	Year 1932-1933: Expenditure, Dollars	Year 1932-1933: Heating Load, Square Feet of Radiation	Coal Required for 1932 Radiation, had no improvement been made, Tons	Estimated Cost of Coal Had No Improvements been Made, Dollars
University of Virginia	1928	5,900	26,705.86	107,861	5,888	21,978.49	173,463	8,600	28,896.00
College of William and Mary	1928	5,600	27,833.00	55,927	6,700	21,785.96	94,944	8,800	39,248.00
State Teachers College, at Farmville	1929	3,400	17,563.65	33,400	2,300	10,445.88	39,600	3,700	15,947.00
State Teachers College, at East Radford	1928	1,400	4,391.92	16,000	1,600	3,322.36	27,000	2,200	8,000.00
State Teachers College, at Harrisonburg (1)	1932	1,800	7,469.97	25,734	1,859	7,713.94	33,828	2,500	10,150.00
State Teachers College, at Fredericksburg (2)	1932	1,360	6,940.20	22,000	1,450	5,828.24	30,005	2,100	9,702.00
Central State Hospital	1930	5,100	24,844.13	54,400	5,000	14,640.78	61,500	6,000	23,160.00
Southwestern State Hospital	1927	5,100	20,689.88	36,000	4,200	14,222.40	52,000	6,600	20,460.00
State Colony for Epileptics and the Feeble-minded	1931	2,800	12,235.51	31,000	2,500	6,368.06	40,000	3,500	11,900.00
Capitol Power Plant	1927	1,700	8,958.00	36,000	1,510	6,175.18	36,000	1,950	8,833.50
Virginia Military Institute(3)	1932	4,100	20,264.00	46,936	3,000	11,020.72	68,500	5,200	19,812.00
Total		38,260	177,896.12	465,258	36,007	123,502.01	656,840	51,150	196,108.50

(1) Stoker in operation Jan. 1, 1933.
(2) Stoker in operation Dec. 1, 1932.
(3) Stoker in operation Feb. 15, 1933.

Coal consumed per sq.ft. of connected radiation
Year 1926-1927 = 164 lb.
Year 1932-1933 = 110 lb.
Year 1932-1933 if no improvements = Column 8 = 155 lb.



PULVERIZED COAL, NEW BOILERS AND TURBINES PAY OUT IN FIVE YEARS

By J. M. LENONE
Designing Engineer,
Wilson & Co., Inc.

Pulverized coal, integral economizers and tubular air heaters replace antiquated boilers and natural-draft chain-grate stokers. Steam pressure stepped up so that 2-point bleeding and 10-lb. exhaust can be used for heating and process. Bleeder turbines provide power formerly purchased

RAPIDLY increasing maintenance costs in the Chicago plant of Wilson & Co., Inc., led to this replacement. Large process steam demands make a packing plant ideal for recovery of by-product power, so the new plant burns pulverized coal, recovers power from process steam, and uses non-condensing bleeder turbine-generators to maintain heat balance. Placed in operation in January, this plant is expected to pay for itself in five years.

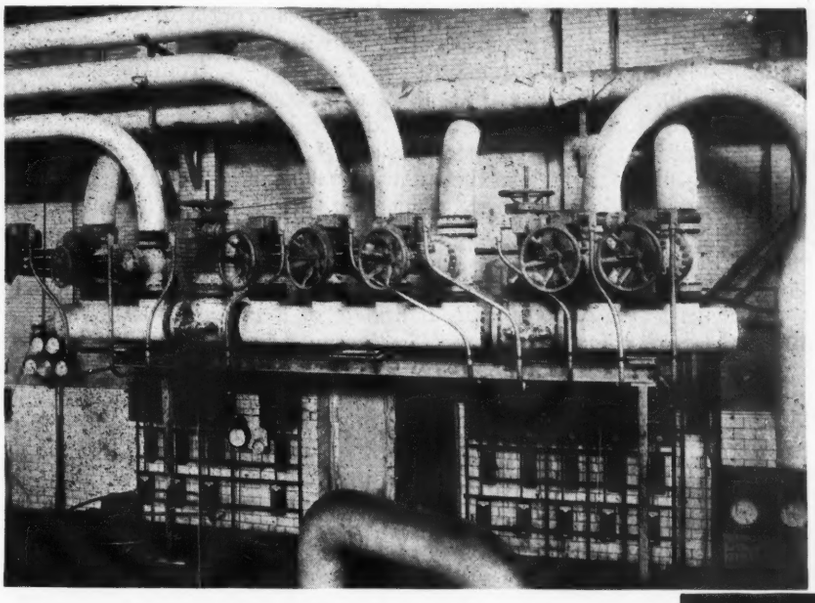
Its design was based on these data: Electric current formerly purchased cost $110,000 a year, with the demand meter registering 3,500 kw. Steam was produced at 150 lb. gage, with steam demand 152,000 to 260,000 lb. per hr. during the winter and 116,000 to 224,000 lb. per hr. during the summer. The average was 190,000 lb. in winter and 151,000 in summer. Seven of the nine water-tube boilers were being operated with natural-draft chain grates at 67 per cent commercial efficiency. Generated at 150-lb., boiler steam drove engines and turbines operating ammonia and air compressors and pumps, and fed processes at various pressures. About 40 per cent of the engines and turbines operated on barometric condensers from which the tail water was used as hot-house water. The rest operated at 5 lb. back pressure to provide exhaust steam for house and process heating.

Steam is produced in the new plant at 380 lb. gage and 550 deg. Superheated 106 deg., this steam is supplied to three turbine-generators of the non-condensing type, bleeding at 155 lb. gage to the present lines supplying the engine and turbine drives, and at 85 lb. gage to high-temperature, process-steam lines. Turbines exhaust at 10 lb. back pressure to low-temperature process and heating for buildings and products. These units generate 3-phase, 60-cycle, alternating current at 480 volts.

Steam-generating equipment consists of three 11,220-sq.ft., bent-tube boilers of the 4-drum type, with convection superheaters, 2-drum integral economizers and tubular air heaters. Four pulverized-coal burners per unit are in the wall under the mud drum, and this wall and the side walls are sectionally supported and air cooled. The roof and the wall opposite the burners are water cooled by bare tubes, and there is a bare-tube

water screen across the furnace above the ash-hoppered bottom.

Coal is dumped from cars into a track hopper, and carried by an apron conveyor to a ring crusher sizer. Belt conveyor and bucket elevator raise it to a belt conveyor distributing to an overhead bunker topping the central firing aisle. The bunker is of precast reinforced concrete slabs supported in steel straps suspended from steel girders and columns. Coal leaves the overhead bunker through chutes to continuous



weighing machines which drop it into ball tube mills, two to each boiler. Primary air blowers draw pulverized coal from the mills and deliver it through ducts to four burners on each boiler.

Forced- and induced- draft fans, one each per boiler, are above the boilers. Fans are driven by synchronous motors through variable-speed hydraulic couplings. The forced-draft fan draws the air through the hollow air-cooled furnace walls and delivers it to the air heater. Air leaving the heater is divided, part going to the pulverizer mills as primary air to convey the coal to the burners and part going direct to the burner boxes as secondary combustion air. The induced-draft fan draws gas from the furnace through double-inlet boxes in the form of cyclone dust concentrators and discharges them to a short steel stack. Concentrated dust from the fan-inlet cyclones goes through secondary elimination cyclones from which the dust drops into receivers, and the cleaned air goes back to the fan suction.

City water, for boiler feed, first goes to a 5-lb. steam pressure open heater on top of a settling tank holding a 1-hr. supply. Hot water leaves the bottom of the heater through a mixing throat where treatment chemicals are added. Hot treated water goes to a settling tank, then through filters and booster pumps to a deaerating heater using bled steam at 85 lb. Boiler feed pumps deliver water from the deaerating heater to the economizers.

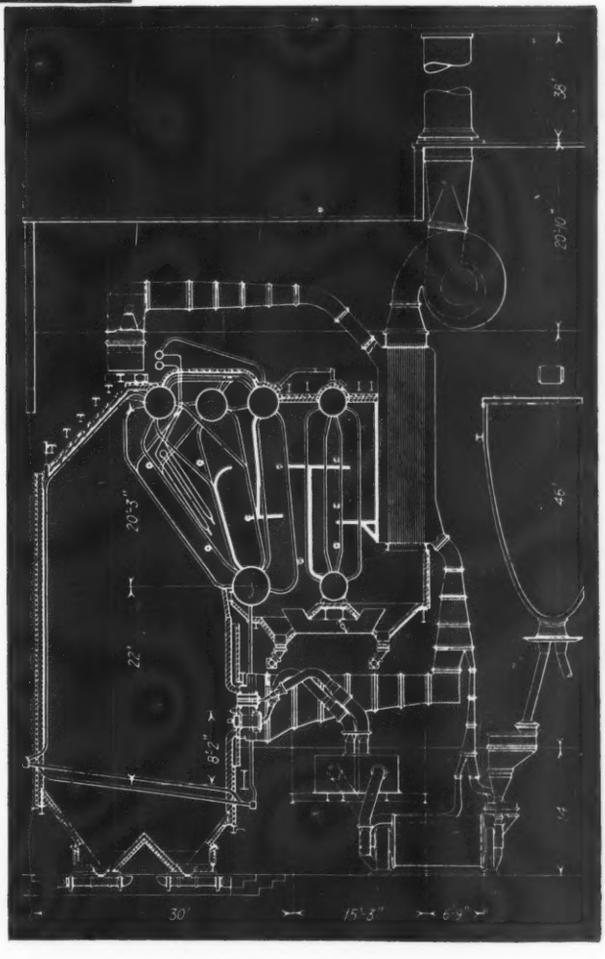
Condensate return lines discharge into a treating tank for removal of oil and grease. After being filtered, condensate passes into the feed-water settling tank. Boiler water is further conditioned by being drawn from the boiler drums through filters (any further treatment required is introduced before filtering) and returned to the bottom header of the water-wall tubes. Besides conditioning the boiler water, this action stimulates circulation through the water-wall tubes.

Ash and dust are removed through a pneumatic ash conveyor system. Ash hoppers under the furnaces, fly-ash hoppers between boilers and economizers and between economizers and air heaters, as well as cyclone dust collectors at the induced-draft-fan inlets, are all connected to this system. Ash is dumped from storage through a "dustless" unloader to railroad cars.

Except for two of the four boiler-feed pumps and two of the three booster pumps, which are driven by turbines operating at 10 lb. back pressure, all equipment is motor driven. Motors are under pushbutton control. There is a control board for each boiler, the three being arranged to form an open triangle.

Left—Main 12-in. high-pressure header, equipped with motor-operated valves remote-controlled from panels below

Below—Longitudinal section through half of new boiler room



Three new turbine-generators have been installed in the old engine room. These machines are rated at 3,125, 2,500 and 1,875 kva. capacity, with a present power factor of 90 per cent. Boiler-room electric drives have increased day load demand to about 4,000 kw. At this load, steam demand at the turbine throttle will be 172,000 lb. per hr. The 155-lb. bleeder will supply 94,000 lb. of steam per hr., the maximum required to operate the older engines and turbines. The 85-lb. bleeder will supply 40,000 lb. of steam per hr., the maximum required for high-temperature process work. This leaves 38,000 lb. per hr. of 10-lb. exhaust, which will be augmented by about 56,000 lb. of steam from the older non-condensing units. Maximum demand for 10-lb. steam approximates 95,000 lb.

Pressure-reducing and de-superheating stations have been provided between the pressure headers. In this way, the 85-lb. header may draw from the 155-lb. header, and the latter from the boiler header.

The plant has not yet settled to its most efficient basis. As in all new installations, there are minor difficulties to overcome. Observation under favorable operating conditions has indicated over-all efficiencies of at least 85 per cent, and it is anticipated that average operating efficiency will be better than 83 per cent.

Principal Equipment, New Wilson Power Plant

Boilers, bent-tube, multiple circulation, three, 11,220 sq.ft., 420 lb. max. pressure...Combustion Engineering Co.
Water walls and screens, three, 1,570 sq.ft.. Combustion Engineering Co.
Integral economizers, three, 4,830 sq.ft. Combustion Engineering Co.
Air heaters, three, 13,788 sq.ft. ..Lasker Boiler & Engineering Co.
Cross-tube baffles, Acme .....R. E. Copeland
Superheaters, three, 130,000 lb. per hr., 110 deg. F. superheat .....Superheater Co.
Soot blowers .....Diamond Power Specialty Corp.
Air-cooled walls .....M. H. Detrick Co.
Feed-water regulators .....Swartwout Co.
Pneumatic ash conveyor, 75-hp. Allis-Chalmers motor .....United Conveyor Corp.
Fans, forced-draft and hydraulic couplings, three, 49,000 c.f.m. at 140 deg., 100-hp. Westinghouse syn. motor .....American Blower Corp.
Fans, induced-draft, hydraulic couplings and dust collectors, three, 70,400 c.f.m. at 340 deg., 150-hp. Westinghouse syn. motor.....American Blower Corp.
Low-pressure heater and hot process softener, 20,000 gal. per hr., ...Graver Tank & Mfg. Corp.
Condensate oil-removal system, 11,000 gal. per hr. .....International Filter Co.
Deaerating heater, 242,550 lb. per hr., 215 to 324 deg. .....Elliott Co.
Booster pumps, three, 520 g.p.m., two turbine, one motor drive .....Ingersoll-Rand
Boiler-feed pumps, four, 310 g.p.m. two 150-hp. Allis-Chalmers motors and two Westinghouse turbines .....Worthington Pump & Machinery Corp.
Percolation system of filtration, three, 120 g.p.m., three 3-hp. motors .....Rolston Engineering Co.
Coal handling equipment: crusher, 60 tons per hr., to ½ in., 50-hp. Allis-Chalmers motor American Pulverizer Co.
Conveyor system, 60 t/hr., four Reliance motors, 2 to 7½ hp. .....Link Belt Co.
Bunker, precast reinforced concrete slabs, 260 tons .....Riff Engineering Co.
Coal scales, six, 6 t/hr. each, ½-hp. motor ....Richardson Scale Co.
Pulverizers, six, 8,000 lb. per hr., Westinghouse motors, 75, 15 and ¼ hp. ....Kennedy-Van Saun Mfg. & Eng. Corp.
Ducts and burners .....Kennedy-Van Saun Mfg. & Eng. Corp.
Turbine-generators, three, 3124, 2500 and 1875 kva., two-point bleeding, 10 lb. back pressure General Electric Co.
Bleeder check valves, five, 12-in. .....Atwood & Morrell Co.
Main bus structure, switching equipment and boiler auxiliary control .....Westinghouse Elect. & Mfg. Co.
Motor-operated h.p. main valves, Cutler-Hammer Inc., control .....Chapman Valve & Mfg. Co.
Desuperheating equipment .....Swartwout Co.
Boiler triple non-return valves, three, 10-in. Golden Anderson Valve Specialty Co.
Safety valves .....Ashton Valve Co.
Blow-off valves, Yarway, seatless tandems ....Yarnall-Waring Co.
Feed and check valves .....Edward Valve & Mfg. Co.
Gage columns and micasight gage ....Reliance Gauge Column Co.
Pressure reducing valves .....Boylston Steam Specialty Co.
Auxiliary steam and water valves .....Wm. Powell Co.
Recording thermometers .....Taylor Instrument Co's.
Flow meters .....Republic Flow Meters Co.
Feed-water level, recorder and indicator.....Bailey Meter Co.

Until records over a longer period are available, estimates must serve. The saving in the new plant as compared to the old has been figured thus: An average year's operation formerly required 88,225 tons of coal. Approximately 1,345,000,000 lb. of steam per year, from a boiler feed temperature of 225 deg. F. to a pressure of 150 lb. gage, was produced at a commercial efficiency of 67 per cent. Now, the steam quantity demand for process and heating remains the same and is in excess of that required at the turbine throttle to produce the electric energy. Therefore the 1,345 million pounds of steam per year will meet the new requirements. It will be produced, however, at 380 lb. pressure and 550 deg. F., from feed water at 324 deg. F., and at a commercial efficiency of 83 per cent. The actual difference in the heat content of steam per pound is only 1,276.5 — 1,195 = 81.5 B.t.u. Roughly, the annual coal consumption should be reduced in accordance with the ratio of efficiencies, taking into account, of course, the differences between feed-water temperatures and heat contents of the steam. In round numbers, a reduction from 88,000 to 70,000 tons is indicated, or a saving of 18,000 tons of coal per year. To this must be added the former cost of purchased electric power and a saving of sixteen men. The present staff consists of four men on each 8-hr. shift. In addition, there are five men all told on coal and ash. After deducting overhead a net saving over previous operating cost is anticipated that will amortize the new plant in about five years.

WHEN? WHAT? WHY?

Asks THEO. J. DICK
Milwaukee, Wis.

Compare your answers with those on page 192. More questions next month.

1. Is this statement true or false: "The warmer a body is, the faster the molecules move."
2. When does a solid, upon application of heat, change into a liquid?
3. When does a liquid change into gas?
4. What causes boiler pressure?
5. What is heat?
6. What are the effects of heat on life?
7. What are the effects of heat on material substances?
8. What is our greatest natural source of energy?
9. What is kinetic energy?
10. What is potential energy?
11. How do we obtain the greater part of heat directly?
12. What is sensible heat?
13. Does the thermometer indicate the quantity of heat in a room?
14. Mercury freezes at —39 deg. F. and boils at 680 deg. F. What are the corresponding readings on the Centigrade scale?
15. Air liquefies at 180 deg. below zero Centigrade. What is the Fahrenheit equivalent?
16. What is absolute zero?
17. What is absolute temperature?
18. To what absolute temperatures do 60 deg. F. and —30 deg. F. correspond?
19. What is meant by the latent heat of steam? What is its value at 212 deg. F.?
20. What is meant by the latent heat of water, and what is its value?

PROPELLER PUMPS IN PARALLEL

5 ways to start them without overloading driving motors

By C. B. TULEY

Steam Condenser Engineer,
Westinghouse Electric & Mfg. Co.

PROPELLER pumps require higher shut-off power than centrifugal pumps, as indicated by the curves, but do not require oversize motors because shut-off operation can be avoided. This is particularly important when two propeller pumps serve one condenser, and one pump is started with its discharge valve closed while the other is operating.

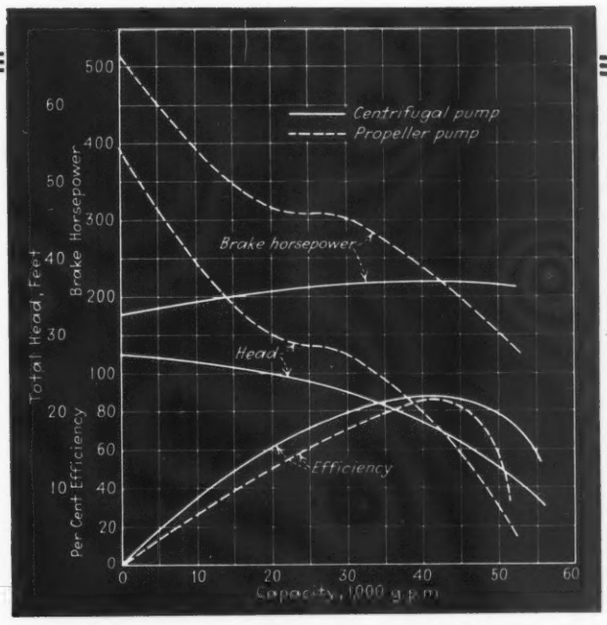
1. This arrangement includes a non-reversing mechanism consisting of a brake band held around the coupling between pump and motor by a linkage and spring. When the pump starts to reverse, it pulls the brake tight and stops rotation. This has been used satisfactorily in a large central station on horizontal centrifugal circulating pumps and is readily adaptable to propeller types. The procedure in starting one pump with the other operating is:

The discharge valve of the idle pump is opened a predetermined amount, allowing water to flow through it from the inlet waterbox back to the intake tunnel. Reverse rotation is prevented by the non-reversing mechanism. The pump is started and delivers enough water through the partially opened discharge valve so that it does not operate through the shut-off point; then the discharge valve is opened.

The non-reversing mechanism will also prevent reverse rotation if power to one motor is cut off temporarily while both pumps are operating. This allows the pump to restart immediately without shutting the discharge valve to stop reverse rotation.

2. This arrangement uses a bypass around the discharge valve large enough to bring power requirements within a safe load on the motor. This bypass contains a check valve to prevent water flow from the waterbox through an idle pump to the intake tunnel. When the idle pump is started, it discharges through the bypass line until sufficient head has been created to open the check valve against circulating-system pressure. Therefore, the pump never operates against full-speed shut-off head. This system is particularly good in medium-size installations, in which the bypass can be comparatively small.

3. A full-size check valve is put in the discharge lines. This allows the idle pump to be started as with the bypass line and check valve. After starting the pump, the check valve may be opened wide by external means to reduce head loss through the valve.



Characteristics of propeller and centrifugal pumps

4. A bypass from the pump discharge, either from an opening in the pump casting or from the discharge piping back to the intake tunnel, forms this system. A valve in the bypass is opened, then the pump is started, thus allowing enough water to flow to the intake tunnel to prevent excessive power requirements. The main discharge valve is opened and the bypass closed after the pump is started. By using a motor-operated bypass valve, controls may be so interlocked that bypass is opened, pump started, main valve opened, and bypass valve closed, all automatically.

5. Where direct-current auxiliary power is used, the pump can be started at slow speed with its discharge valve closed, then brought up to speed as the valve opens. When started this way, the pump does not go through the full-speed shut-off condition. For example, assume two 7,500-g.p.m. pumps operated together against a 16-ft. total head, each driven by a 40-hp., 1,170-r.p.m. motor. Assume that the head with one pump operating alone is 8 ft. If the idle pump were started and operated at 1,170 r.p.m., it would require 65 hp. when the discharge valve was closed. This is an excessive overload for a 40-hp. motor. By running the pump at 600 r.p.m. with discharge valve closed, the shut-off head would be 12 ft. and the power required approximately 9 hp. Since the shut-off head exceeds the circulating-system head created by the operating pump, the discharge valve may be opened and the pump brought to full speed. Head in the circulating system will gradually increase to 16 ft., with each pump delivering 7,500 g.p.m. at 1,170 r.p.m.

This system may also be used with wound-rotor a.c. motors. These motors, however, are not often used for circulating-pump drives, because usually not more than one or two speeds are required. A one- or two-speed squirrel-cage motor is usually used, being less expensive than a wound-rotor motor of the same capacity.

NEW TURBINES with OLD BOILERS

MAY PAY QUICKEST IN PACKING PLANT

By J. Y. DAHLSTRAND
Chief Engineer, Turbine Dept.
Murray Iron Works Co.

Often, a small investment in power equipment pays a big return. Turbine-generators installed in old boiler plants are here shown to be a decidedly economical move

MANY industrial plants have modernized their power facilities by putting in high-pressure, high-temperature boilers and turbines to generate by-product power and permit proper heat balance. But it is not always the completely new plant with high pressure and temperature and perfect heat balance that is most practical, nor do the very costly installations always pay good dividends.

As a matter of fact, numerous industrial plants, notably in the packing industry, have found that by installing suitable steam-turbine generators designed to work with existing boiler plants, attractive savings have been obtained. High pressures and temperatures and proper heat balance are not always synonymous with large returns on invested capital.

While from the engineer's standpoint the ultimate in efficiency is to be desired, the buyer must reckon with interest rates and retirement time. In many cases it is the smaller investment that pays the higher rate of return.

If the boiler plant is old and ready to be scrapped, there is, of course, nothing to do except install new equipment. Greatest economy will result from installing the most modern equipment with pressures and temperatures dictated by highest operating efficiency. In such cases, the boiler plant may properly be left out of calculations to determine savings from a power plant, for, in any event, whether purchasing power or making it, a boiler plant is needed.

If the boiler plant, as is frequently the case, is in reasonably good condition, with allowable pressures from 150 to 250 lb., then one of several different types of turbine units will often work out advantageously. In such a case, the turbine is generally designed to accommodate higher pressure at some future time when the boilers have outserved their useful life.

In packing plants, steam at about 75 lb. is needed in considerable quantities for rendering and cooking, and other steam at about 5 lb. for heatnig of water, for plant heating in winter and feed-water heating. In addition, most packing plants use a certain amount of high-pressure steam to drive steam-engine compressors and various types of steam pumps for boiler feed and general service.

When power is not generated, steam for the intermediate pressure (75 lb.) is supplied through reducing valves from the boilers. Low-pressure steam demand in excess of the exhaust of the compressors and pump is also made up from the boilers.

How such a plant will look in a diagram after the installation of a power unit is illustrated in a general way by the diagrams, depending on conditions.

Generally, piping changes are minor, for the turbines are made to exhaust into existing low-pressure lines and bleed into existing intermediate-pressure lines. Two units, each able to carry the full load, are generally installed.

Electric power is generated through the expenditure of certain heat units in the steam, the average of which runs from 2 to 8 per cent of the total heat available. (For condensing bleeders the percentage will of course be higher.) This expended heat energy is, however, frequently offset in part, or even wholly, by leveled-off boiler load, with resulting bettered combustion conditions as well as savings due to bettered heat transfer with wet steam, so that it is not infrequently found that coal consumption after installation of power units shows no increase over that existing at the time power was purchased.

The power-plant layout shown in Fig. 1 is the simplest, but is generally not possible unless the boiler pressure is relatively high, from 250 to 300 lb. Even then, other conditions must be favorable to permit an installation of this kind with best economy. Two non-condensing turbine units are here used, both designed to exhaust at 75 lb. For the low-pressure requirements, steam is throttled from the 75-lb. line.

The compressor units in this and in the following illustrations are assumed to be capable of operation with pressure reduced to 75 lb. As they are usually of the Corliss type, this can generally be done, although of course with reduced efficiency (usually not a vital consideration here).

The plant arrangement shown in Fig. 2 is suitable for plants with steam pressures down to 150 lb. Here one of the turbines is designed to bleed at 75 lb. and exhaust at 5 lb. The other is a stand-by unit designed for 5 lb. back pressure.

Bleeding is accomplished through an automatic bleeding or extraction mechanism operating to supply exactly the required steam demanded at a given moment, thus increasing operating efficiency.

With this plant (Fig. 2), there may be times when prefect balance is not obtained. Some engineers consider it fair to figure that the loss represented by the

steam exhausted to the atmosphere is only the cost of the resulting additional fuel burned. They figure that if a plant shows a balance 95 per cent of the time, this is a fair method of figuring. While this is not strictly correct, it is true nevertheless that momentary unbalances are generally less costly than is popularly supposed.

In the plant layout of Fig. 3, the unbalance was marked enough so that it was thought advisable to make the bleeder turbine exhaust to a condenser. This represents the most common case.

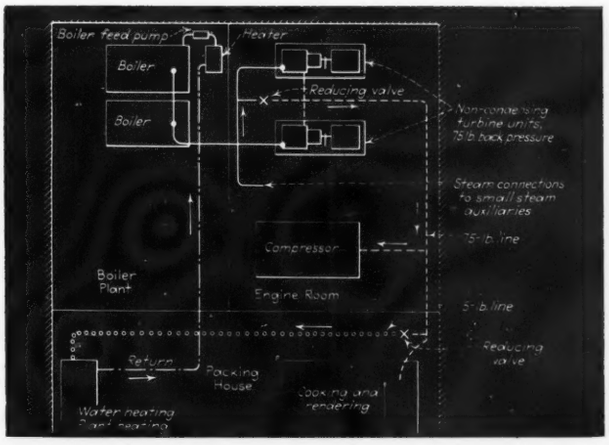
A fortunate circumstance attending this layout is the fact that packing plants usually have available a good quantity of 70-deg. waste water from the ammonia compressors which may be used for condenser circulating water.

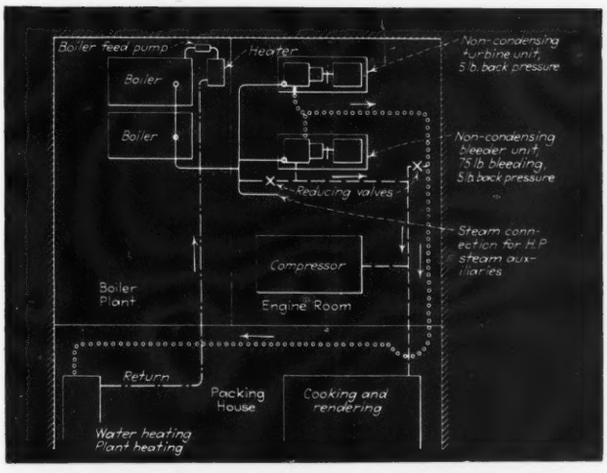
Monthly costs for steam and power in a small-size packing plant are shown in Tables I, II and III for an old boiler room using purchased power, a new modern high-pressure boiler plant and turbine-generator as in Fig. 1, and a new turbine-generator using steam from the old boilers of Table I. The plant considered has an average monthly kill of 3,000 hogs, 300 cattle and 300 sheep. Boilers are not new but in good condition and operate at 175 lb. pressure. Power is purchased at 2c. per kw-hr. and electrical consumption averages 60,000 kw.-hr. a month. Four hundred tons of coal at $2.75 per ton delivered are burned per month. Table I shows the cost of steam and power, less labor, for this plant.

If high-pressure boilers, superheaters, stokers and high-pressure turbine generator and piping, all for 450 lb. pressure and 100 deg. superheat, were installed, total investment would be about $90,000, on which the fixed charges for interest, depreciation and insurance are considered at 10 per cent. The costs for this plant are shown in Table II, and savings over the costs for power and steam in the original plant, as shown in Table I, are not very attractive.

If only a new generator with piping and switch board were installed, using steam from the old boiler, the investment would be about $23,000 and the costs as shown in Table III. The saving of $10,180.92 a year makes the investment of $23,000 very attractive, particularly as the generating equipment can be designed to care for possible higher-pressures in the future.

Fig. 1 (Top)—This arrangement usually requires high steam pressure in order to generate power required. Fig. 2 (Middle)—Bleeder and non-condensing turbines supply both intermediate- and low-pressure steam. Fig. 3 (Bottom)—Condensing bleeder units when power and process steam requirements are unbalanced





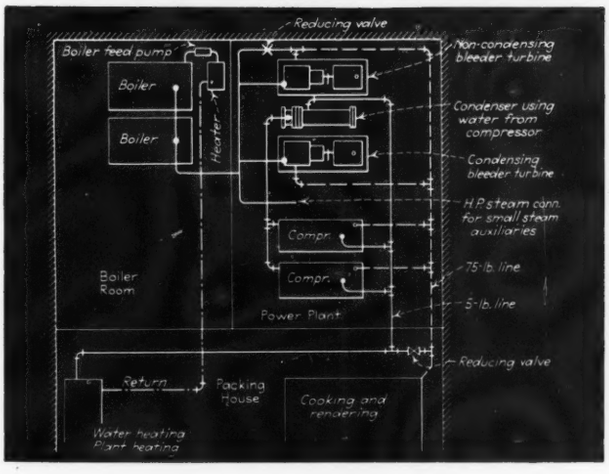


Table I—Power-Steam Costs, Present Plant

		Monthly Cost
Power purchased	60,000 x $0.02	$1,200.00
Coal	400 x $2.75	1,100.00
Maintenance		160.00
Fixed charges		None
Labor (Same all cases so left out)		.....
Total less labor		$2,460.00

Table II—Power-Steam Costs—New High-Pressure Plant

		Monthly Cost
Power purchased		
Coal	280 tons x $2.00	$ 560.00
Maintenance		200.00
Fixed charges	0.833% x 90,000	749.70
Total less labor		$ 1,509.70
Monthly Saving		950.30
Yearly Saving		$11,403.60

Table III—Power-Steam Cost—New Generating Unit Only

		Monthly Cost
Power purchased		....
Coal		$ 1,220.00
Maintenance		200,00
Fixed charges	0.833% x $23,000	191.59
Labor		.....
Total less labor		$ 1,611.59
Monthly Saving		848.41
Yearly Saving		$10,180.92

MODERN

ELEVATOR-DOOR OPERATING EQUIPMENT

RELIABLE—SAFE—QUIET—EASY TO OPERATE

By F. A. ANNETT
Associate Editor

GOOD elevator operation often is, fundamentally, maintaining operating schedules. But operators cannot be expected to do this unless elevator hoistway doors operate easily, particularly if they are hand-operated. When hoistway doors are hard to handle, it is difficult to keep good operators, and operators that can be kept will use hard door operation as an excuse for not maintaining schedules and for neglecting their work.

Hangers on earlier type hoistway landing doors were crude and unsuited to the service, in many cases too light to stand up and with sleeve bearings in the sheaves. All these faults contributed to difficulties in handling and maintenance. Engineering development work has resulted in simple, substantial ball-bearing hangers. Fig. 1 illustrates one type. The door is carried on a heavy, steel rail rigidly mounted on the hoistway wall. Running surfaces are finished by grinding, as are those of the oversize ball-bearing sheaves of the heavy hanger. Two sheaves are welded, one near each side of the door, to a heavy steel bar attached by cap screws to the top reinforcing bar of the door. Door-bottom clearance is adjusted by adding shims between door and hanger bar.

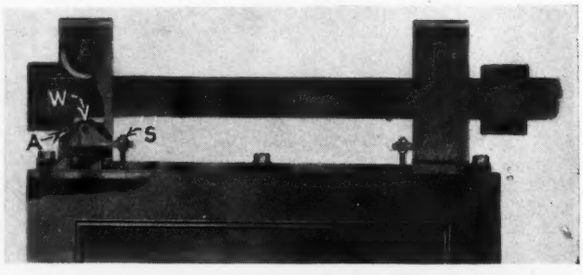
There is a tendency for doors to be thrust up when force is applied to open or close them. Accurately ground hardened steel wheels, running on ball bearings, take this upward thrust. Various methods are used to keep this wheel in contact with the lower edge of the rail. The wheel at *W*, Fig. 1, for example, is mounted on a fitting pivoted at *A* to the hanger. An adjusting screw *S*, at the other end of the fitting, raises or lowers the sheave to give desired clearance between wheel and rail. In other types, the upthrust roller runs on an eccentric stud which is turned for adjustment.

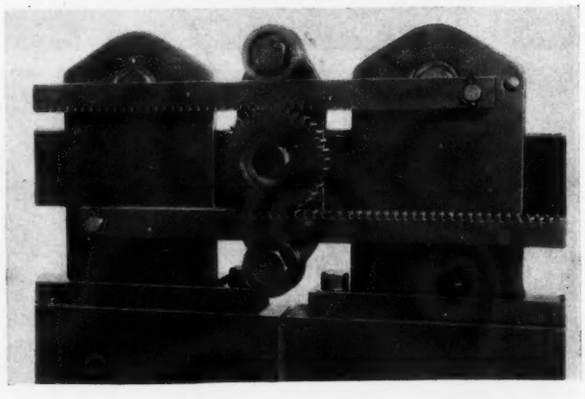
Single doors, supported on two hangers as in Fig. 1, are usually used on small cars and slow-speed doors. This simple arrangement requires but little operating equipment. Car and hoistway doors for medium-size elevators are frequently made in two sections, opening either from the center (center-opening doors), Figs. 2 and 3, with the doors opening one to each side, or with both doors opening from one side (two-speed doors), Figs. 7 and 10, in which case one section slides back over the other. The center-opening type is simpler and requires but one rail, but if space is limited will not provide any greater opening than does a single door. If door travel must be confined to car width, then the two-speed type is preferable, for this permits a door opening two-thirds car width. This arrangement requires two tracks, however, and operating equipment is more complicated.

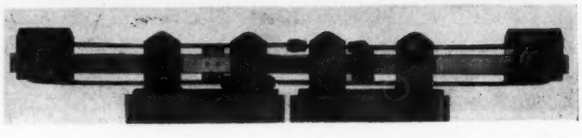
Two-speed doors are never as neat in appearance as single doors or single center-opening type, because one section must lap over the other. If unusually large door openings are required, however, a center-opening two-speed, or even a center-opening three-speed design may be required, even though operating mechanism is complicated. The three-speed design requires three tracks, the two inner sections passing in back of the outer one as the door is opened.

Where single-speed, center-opening doors are manually operated, some means must be provided to synchronize the movement of the sections. The rack-and-pinion arrangement, Fig. 2, consists essentially of a pinion and two hold-down rollers, all ball-bearing mounted, centered on the rail between the doors. Each

Fig. 1 (Top)—Elevator door hanger and top of door. Fig. 2 (Center)—Pinion and rack connection between center-opening doors. Fig. 3 (Bottom)—Cable connection between center-opening type doors







inner door hanger carries a pivoted rack engaging the pinion, thus requiring the two doors to operate synchronously.

Another arrangement for accomplishing the same result is shown in Fig. 3. Here the inner or front hangers are joined by a cable passing over sheaves at the outer ends of the rail. In the figure rubber-covered cable is used to connect the hangers together and to give quiet operation. Others use silent chain.

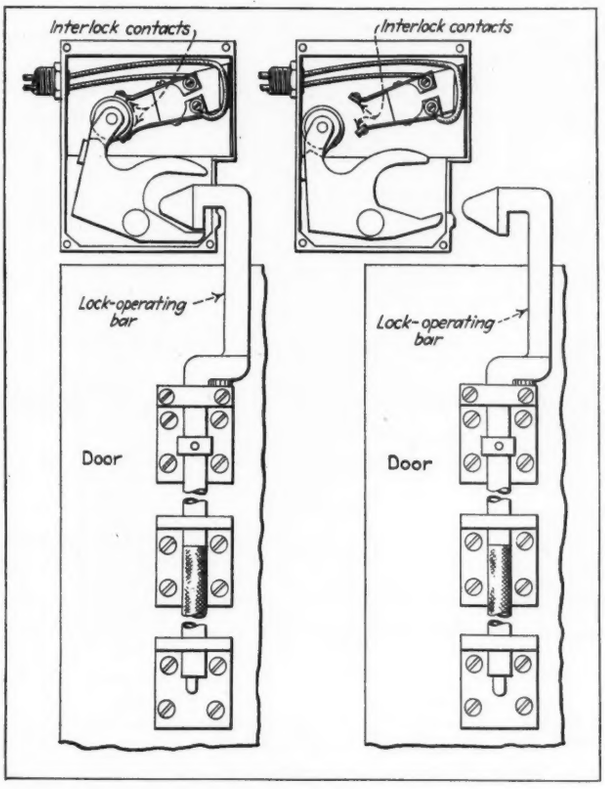


Fig. 4 (Left)—Door lock and interlock in closed position. Fig. 5 (Right)—Same as Fig. 4, but lock and interlock are open

Hangers and operating equipment are also available for two-speed center-parting arrangements (four doors, two moving in each direction), and for three-speed one-way opening doors (three doors, two passing behind the third), but these are simply more elaborate arrangements of those already described.

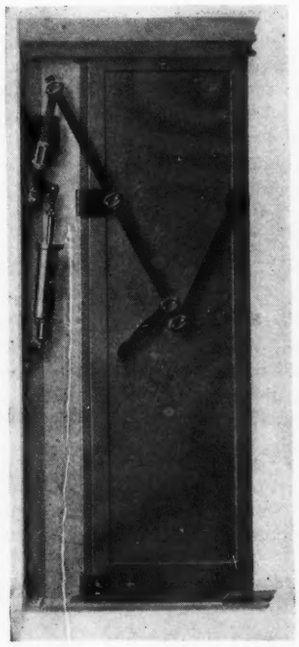
Arrangements for operating and interlocking elevator doors are legion, so only some common manual types will be described. A vertical-type door-operating bar and interlock, Figs. 4 and 5, combines mechanical lock and electrical interlock so that the latter is forced open when the door is unlocked and is closed when the door locks. The operating bar is mounted on the door, the interlock on the door frame. Fig. 4 shows the door closed, with the lip of the lock latch forcing one arm of the interlock bell-crank down, thus forcing the other arm, carrying the contact roller, into contact. In Fig. 5, the door has been opened, the latch has released the bell-crank and it has dropped back, opening the interlocking circuit.

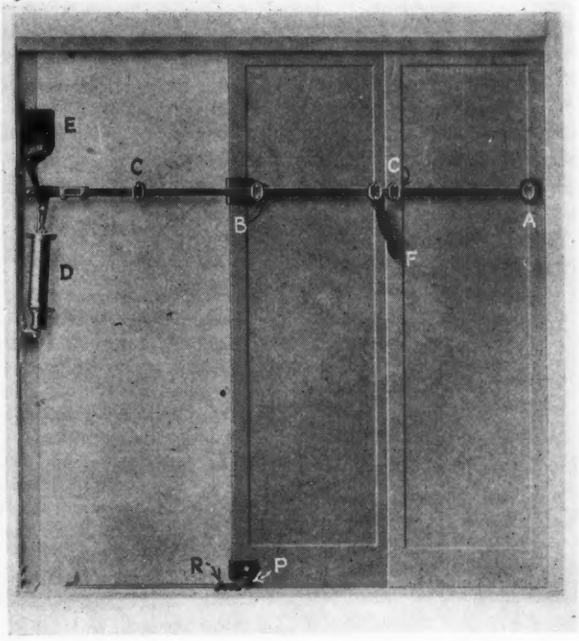
Interlock contacts are in series with the car switch circuit so that the car cannot be operated until doors and interlock are closed. This is essential for safety, because most elevator accidents occur at hoistway doors without interlocks or with interlocks made inoperative.

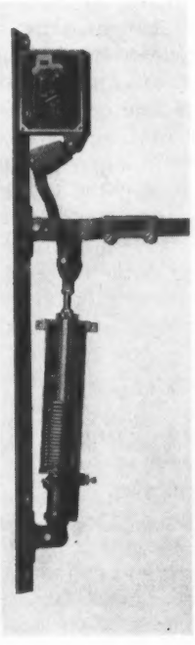
Many types of horizontal manual door operators are used, that shown in Fig. 7 on a two-speed one-way opening door being typical. The operator is fastened to the high-speed door at *A* and to the low-speed door at *B*. The horizontal operating bar is pivoted at *C*, is attached to door-closer *D* and electrical interlock *E* on the door frame. To open the door, the attendant pulls to the left on lever *F*, causing the right-hand door to slide back over the left-hand one, as in Fig. 6.

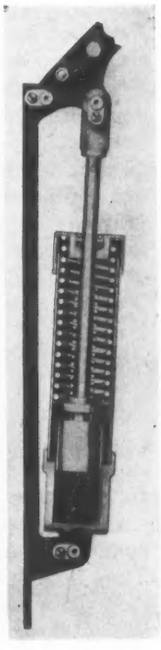
The inside of the door closer and interlock is shown in Fig. 8. The door closer includes a closing spring

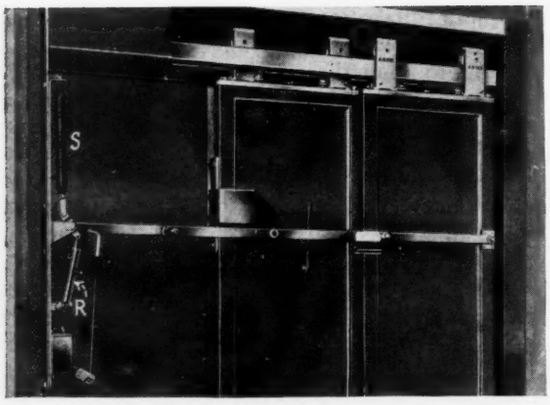
Fig. 6 (Left, below)—Two-speed door and operator in open position. Fig. 7—Two-speed doors and operator in closed position. Fig. 8—Close-up of door closer and interlock of Fig. 6. Fig. 9 (Right)—Cross-section through door closer











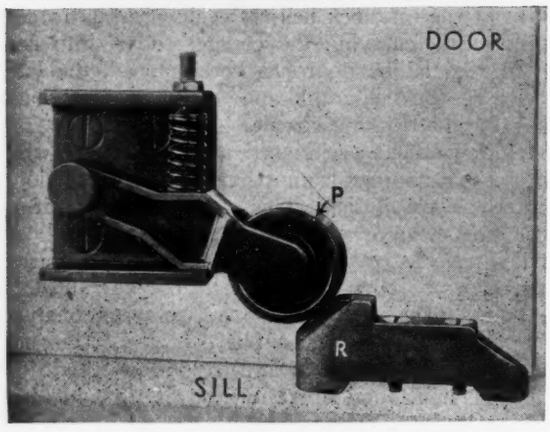


Fig. 10 (Top)—Door-closer spring and retarder mounted as separate units. Fig. 11 (Above)—Device for holding open elevator doors

attached to the plunger and cylinder bottom. At the lower end of the cylinder is the retarding chamber into which a piston enters as the doors approach the closed position. Oil in the cylinder damps the closing action. When the doors are opened, the piston is pulled up as in Fig. 6. This puts the spring in tension and fills the dashpot or retarding chamber with oil. When the doors are released spring tension closes them. The oil damper slows down their motion as they approach closed position to avoid noise or jar. The interlock switch makes contact as the doors close and breaks it as they open.

Other types of door closers compress the spring as they open, as in Fig. 9. An inner, smaller spring, not compressed until the doors are almost full open, prevents the doors from slamming open. This small spring also assists the larger one in starting closure.

Assuming the doors to be closing, Fig. 9, then the piston is just entering the retarding chamber, meeting the oil and forcing it upward through the annular spaces between piston and cup and thus checking door speed. This action grows more pronounced as the doors close, thus avoiding slamming. The checking effect can be adjusted by changing piston travel. Other door closers use needle valves or other adjustable devices for the same purpose.

Closing spring *S* is separate from oil-retarding cylinder *R* in the door operator shown in Fig. 10. Thus both spring and cylinder can be smaller in diameter, allowing the doors to slide past them in opening and giving maximum door opening. The oil retarder acts in both directions, i.e., reslsts slamming at either full open or full closed position. Additional safety is provided by the interlock switch, which drops open if it becomes mechanically disconnected, preventing operation of the elevator. In this it is similar to the interlock shown in Fig. 8.

Rack-and-pawl arrangements, Fig. 7, are used on elevator doors to prevent doors from being forced open by someone attempting to board the car after the interlock closes. When the doors are within 4 in. of being closed, pawl *P* drops back of rack *R*.

Fig. 11 shows a unit for holding doors open. Spring-actuated composition roller *P* drops back of rack *R* on the door sill when the doors are opened and holds them until released by a slight pull by the attendant.

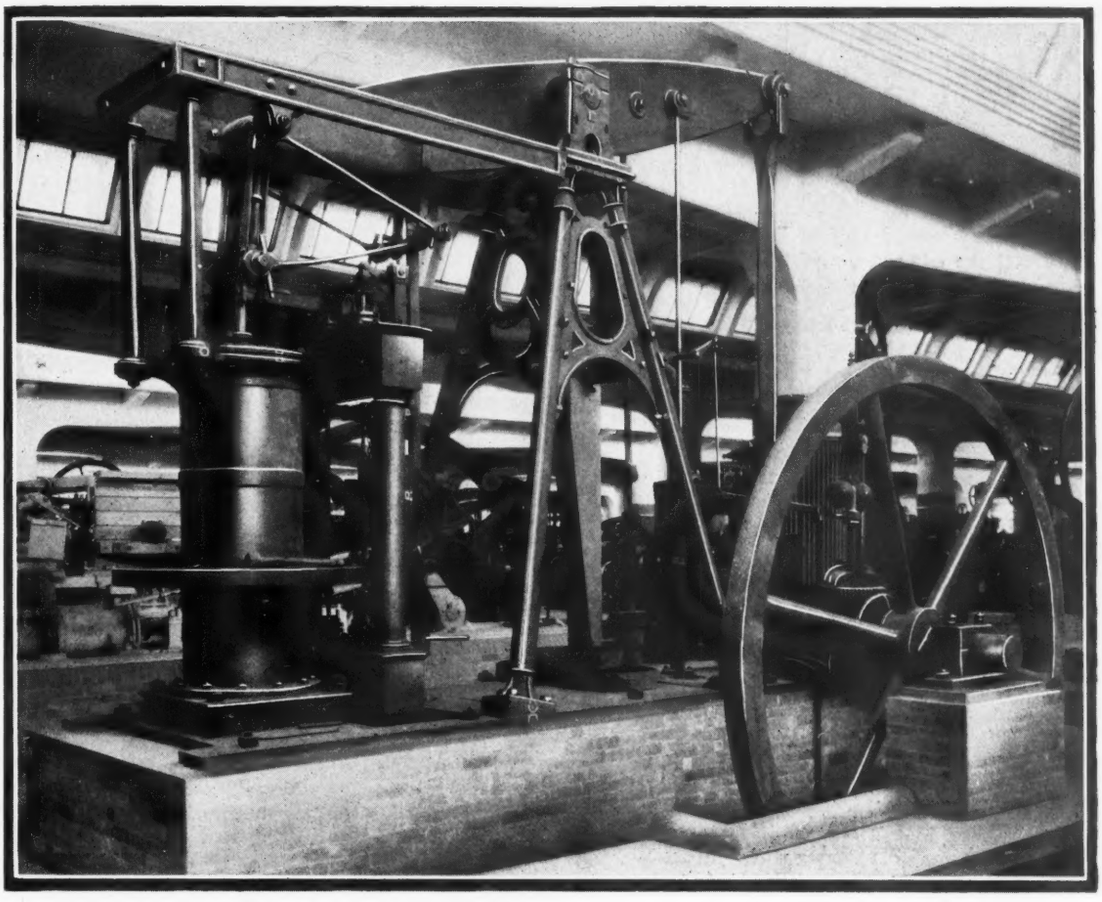
Helpful in the preparation of this article were: Otis Elevator Co.; A. B. See Elevator Co.; Elevator Supplies Co.; Westinghouse Electric Elevator Co.; Gurney Elevator Co.; Wagner Mfg. Co.; Richards-Wilcox Co.

THEO. J. DICK Says

THESE ARE CORRECT ANSWERS

To test questions on page 186.

1. True.
2. When a solid body is heated to a certain point, the molecules need more room for their movement, so the solid changes to a liquid.
3. On further application of heat, a point is reached at which the molecules need more room for their movement than the liquid affords. They now move so fast that they overcome the surface tension of the liquid and shoot out into space forming a gas.
4. These molecules hit the walls of the containing vessel so hard that a pressure is built up.
5. Heat is the energy of motion.
6. Heat affects our comfort. Too much or too little heat destroys life.
7. If sufficient heat is added, all materials (even rock, cement, asbestos, etc.) can be reduced to a gas.
8. The sun.
9. The energy a moving body possesses is called kinetic energy.
10. A body may be capable of doing work because of its position or condition. Such energy is called potential energy. (All combustible materials, suspended weights, stretched coil springs, etc.)
11. Combustion. (The chemical energy in the fuel is changed into heat).
12. Heat added to a substance causing a rise in temperature is called sensible heat.
13. No, it shows only the degree or intensity of heat.
14. —39.4 deg. C.; 360 deg. C.
15. —292 deg. F.
16. It has been found that 460 cu.in. of a perfect gas at zero Fahrenheit will contract 1 cu.in. in volume for each degree the temperature is lowered. At 460 deg. F. below zero all gases contract practically to zero. All molecular motion ceases. We call this point absolute zero.
17. Temperatures reckoned from absolute zero are called absolute temperatures.
18. 520 deg. F. abs.; 430 deg. F. abs.
19. The number of heat units required to turn 1 lb. of water at the boiling temperature (for the existing pressure) into 1 lbs. of steam at the same pressure. Its value at 212 deg. F. is 970.4 B.t.u.
20. The number of heat units required to change 1 lb. of ice at 32 deg. F. to water at 32 deg. F. The value is 144 B.t.u.



No. 5—THE COALBROOKDALE ENGINE

THIS is a double-acting factory driving engine, and may be said to represent the steam engine as Watt left it. It is compact and self contained and possesses all the refinements existing about the year 1800. It has parallel motion, neat cast iron "A" frame, iron beam, cast-iron spring beam, etc., but retains the plug-rod operated poppet valves which Watt so keenly favored.

This engine was used for driving the machinery at the Lightmoore Tile Works, Shropshire, England, where it was erected in 1854, having previously been in use at one of the coal mines belonging to the Coalbrookdale Company, to which company the tile works belonged. It continued in use at this tile works until 1929, when it was purchased by Henry Ford and removed to the Edison Museum. The Lightmoor Tile Works forms part of the famous Coalbrookdale Company, where the first cast-iron cylinders for steam engines were made about the year 1725. This engine is double-acting, has a bore of 20 in., a stroke of 4 ft., and a flywheel 12 ft. in diameter. It is a condensing engine, works at a pressure of 25 lb. per sq. in. pressure and 30 r.p.m. Its maker is unknown, but it probably dates back to the first five years of the 19th century.

It is an interesting fact that this engine should come from an establishment whose early discoveries and experiments did much to aid the practical development of steam power. Prior to 1725, the cylinders of such steam (atmospheric) engines as then existed were made from brass, tin or spelter; cast iron did not form any important part of the machines. About that time, however, the Coalbrookdale Company had so developed the art of making cast iron with coal-coke instead of charcoal that it was able to cast cylinders and other large parts for atmospheric engines. For many years such castings were not obtainable at any other place. The company was started in 1709 by Abraham Darby and still carries on business in Coalbrookdale, Shropshire, where remains of the furnaces which served it more than 220 years ago are still to be seen. The engine cylinder of the Warwick Navigation's Engine, No. 2 of this series, was also cast by Coalbrookdale and is the only one known to exist bearing the inscription of the concern and the date, i.e., COALBROOKDALE 1796.

In the early days of his experiments, Watt was assisted and financed by Matthew Boulton, a wealthy and able manufacturer of Birmingham, England, to whose intelligence and foresight the subsequent development of the steam engine owes much. In 1775, Watt entered into a partnership with Boulton, which lasted until Watt retired in 1800.

STEAM PLANTS THAT MADE HISTORY

MAINTAINING THE QUALITY

DURING the early stages of the industrial era, the lubricants used consisted of a wide variety of products. There were lard oil, fish oil, tallow, whale oil, some petroleum oil and many others. These "lubricants" were applied to the bearing surfaces, and then forgotten. In most cases very little attention was paid to the method of application or to keeping out dust and dirt. No attempt was made to use the lubricant more than once.

Methods of lubrication have changed from the old hand-oiling, all-waste systems to modern systems where lubrication is positive and continuous. In large systems where the oil is used over and over again, another problem has been introduced. This is "maintaining the quality of the lubricant in service".

All the care exercised during the refining process, during the transportation of the lubricant to the consumer, and the care taken by the latter to see that the lubricant is applied in its original condition may be wasted if the lubricant is placed in a system where it may readily become contaminated.

This contamination may be some of the old oil, sludge or similar material lodged in the system, or it may be foreign matter that enters after operation is started. In any case this contamination, unless removed, will reduce the effectiveness of the lubrication obtained.

Therefore there are two phases to "maintaining the quality of lubricants in service", first, preventing the entrance of foreign material and maintaining operating conditions so that deterioration of the oil itself will be at its minimum; and second, removing these substances as soon as they are formed in, or enter into, the lubricating system.

PREVENTING CONTAMINATION

One of the most important factors in the prevention of contamination is the employment of the proper method of storing and handling lubricants, which subject has been covered in a previous monograph.

One of the main causes of contamination during use is the formation of sludge or carbon particles due to the high temperatures encountered at some point or points in the system. While it is impossible to eliminate such formation entirely, the situation may be greatly improved by a careful check of temperatures at the various bearings. If localized heating is reduced, the subsequent removal of contaminants is greatly facilitated.

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REMOVING CONTAMINATION

The three most common methods used to separate impurities from lubricating oil are as follows:

1. Gravity settling or precipitation.
2. Filtration.
3. Centrifugal force.

Gravity settling, or precipitation, accomplishes separation due to the difference in specific gravity between the oil and the impurities. To accomplish the best results, long standing, without agitation, is desirable, and in some cases, the application of heat is used to assist in the separation. Substances removed in this manner are water (but not dispersed moisture), the larger particles of dirt and some sludge. Some emulsions will break on standing, or when heat is applied, while others may not separate at all, or separate only partially.

Gravity settling of this type, used alone, is only of partial benefit in removing contamination. Used in conjunction with other methods, however, it materially aids the latter in functioning properly.

Filtration consists of passing the oil through a material of fine mesh, such as felt. The oil passes through and the suspended solids are retained on the filter cloth. The area and mesh of the filtering media, the viscosity of the oil, the nature of the impurities to be removed and the amount of oil to be conditioned are factors to consider. Heating the oil reduces its body and allows more rapid filtration. However, some sludge materials are more readily dissolved in the oil when the temperature is high and are best removed when the oil is cold. Also some oils contain fine sludges or form stable emulsions which are not removed by "gravity" settling, yet are dense enough to clog up filtering media in a short time. To remedy this, the cause of the sludge formation should be eliminated. In cases where this is not practical, separation by centrifugal means or by coagulation will generally give improved results. In most cases filtration can be relied upon to completely remove dirt and some sludge.

Centrifugal force has been used for many years to quickly separate substances of different specific gravities. In a centrifugal separator the impurities, being heavier than oil, are quickly thrown out and collect in a different section of the separator from the cleaned oil, which is continuously discharged.

This type of system will remove water, moisture, dirt, sludge and soaps which are suspended in, but not dissolved in, the oil. It will also separate many emulsions.

Many reputable manufacturers have incorporated certain of the foregoing principles in their apparatus in such a manner that they fall into two general classes, the "gravity" type and the centrifugal type.

TYPICAL RECLAMATION SYSTEMS

Either of these two reclamation processes may be employed. The batch, continuous partial (continuous by-pass) or continuous by-pass-batch method of reclamation are the most common methods used.

In the batch method, all the oil is removed from the lubricating system and reclaimed, necessitating shutting down the machine. It may remain shut down until the oil is reclaimed, or it may be filled with fresh or previously reclaimed oil.

In the continuous by-pass method, usually ten or twenty per cent of the lubricating oil passes continuously from the lubricating system through a sight feed overflow to the reclaiming equipment. The oil sent to the reclaimer should be taken from the bottom of the oil sump or crankcase where most of the water, dirt, sludge and other impurities collect.

This method is generally used where the oil from several large units, such as turbines, is reconditioned. A portion of the oil from each unit is continuously by-passed as described in the preceding paragraph, maintaining the oil at a high quality. The temperature at which this reclaiming is usually carried on is from 100° to 180° F. Limited amounts of sludge materials are soluble in the oil at these temperatures and are not removed. For this reason an additional batch treatment is given, consisting in periodically draining one of the units and refilling it with reclaimed oil. The oil drained may then be washed with water or chemicals, cooled and allowed to settle for several days or weeks. When cool and completely settled it is put through the reclaiming units and stored for further use, much of the soluble sludge having been removed.

Whether any reclamation system should be employed is, of course, dependent upon the original quality of the lubricant, the type of service and the amount of lubricants involved.

It would not be logical to reclaim a cheap "black oil" used for the lubrication of certain types of exposed gears, while in steam turbines and similar equipment it is highly essential that the oil be kept in good condition at all times.

Whether or not a reclamation system should be used, and if one is used, the type to employ must depend upon a detailed analysis of the entire installation.

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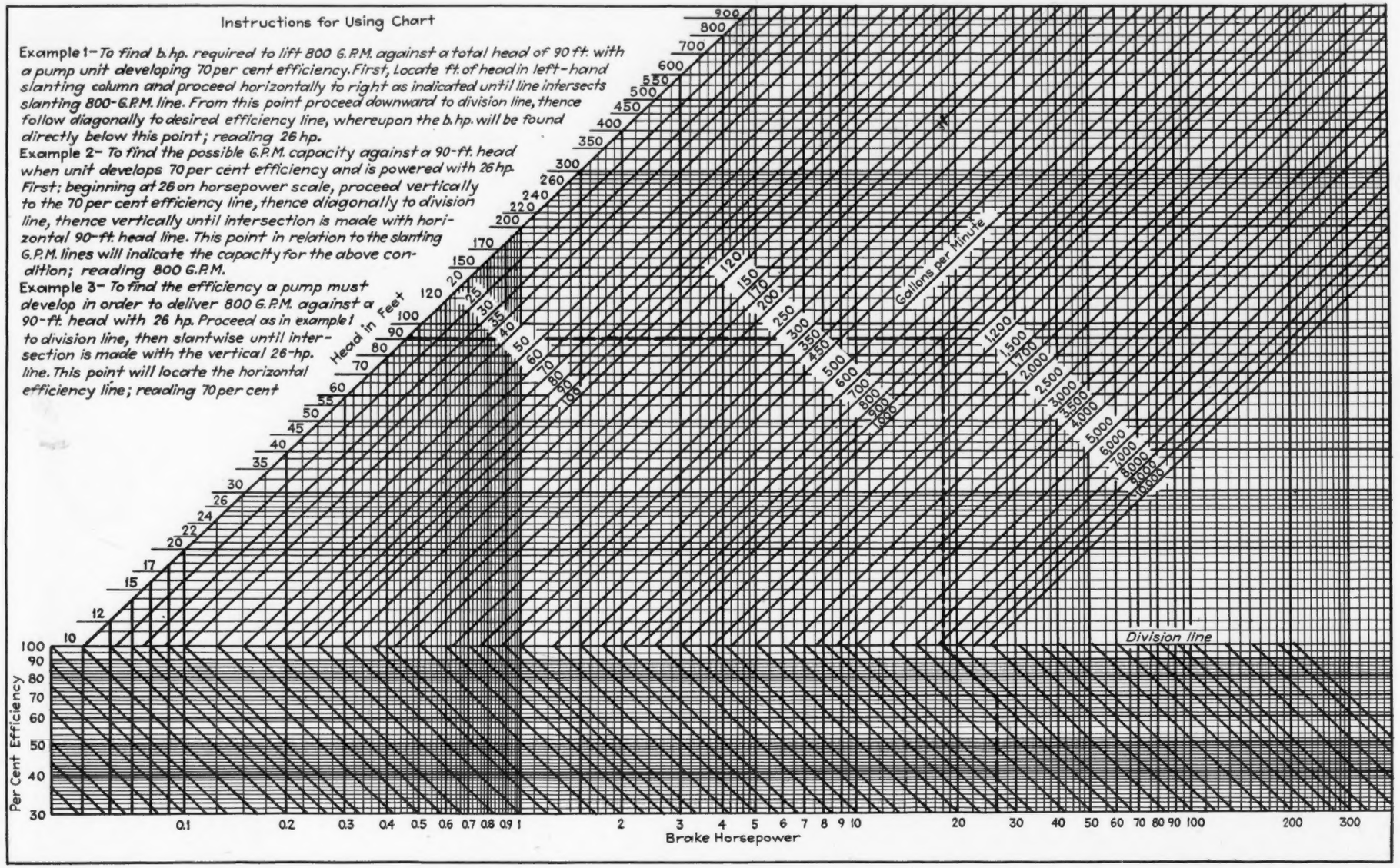
NRA MEMBER U.S. WE DO OUR PART

Chart for Determining Head, Capacity, Efficiency or Horsepower of a Pump

When Any Three Conditions are Known


Instructions for Using Chart
Example 1– To find b.hp. required to lift 800 G.P.M. against a total head of 90 ft. with a pump unit developing 70 per cent efficiency. First, Locate ft. of head in left-hand slanting column and proceed horizontally to right as indicated until line intersects slanting 800-G.P.M. line. From this point proceed downward to division line, thence follow diagonally to desired efficiency line, whereupon the b.hp. will be found directly below this point; reading 26 hp.
Example 2– To find the possible G.P.M. capacity against a 90-ft. head when unit develops 70 per cent efficiency and is powered with 26 hp. First; beginning at 26 on horsepower scale, proceed vertically to the 70 per cent efficiency line, thence diagonally to division line, thence vertically until intersection is made with horizontal 90-ft. head line. This point in relation to the slanting G.P.M. lines will indicate the capacity for the above condition; reading 800 G.P.M.
Example 3– To find the efficiency a pump must develop in order to deliver 800 G.P.M. against a 90-ft. head with 26 hp. Proceed as in example 1 to division line, then slantwise until intersection is made with the vertical 26-hp. line. This point will locate the horizontal efficiency line; reading 70 per cent
Head in Feet
Gallons per Minute
Division line
Per Cent Efficiency
Brake Horsepower

Developed by J. M. Hait, Chief Engineer, Peerless Pump Company, Food Machinery Corp., and copyrighted by the latter. Used by permission.

AIR VELOCITY—NOT TIP SPEED—AFFECTS

FAN-BLADE EROSION

By A. A. CRIQUI
Chief Engineer, Buffalo Forge Company

THE fine ash created by pulverized coal has caused, in many cases, rapid wearing away of induced-draft fan blades and parts of the fan scroll. Serious erosion occurs only when flue-gas velocity over the blades of the blast wheel is high, such as is encountered in systems operating at higher fan pressures. Erosion varies approximately as the square of the velocity of the abrasive particle of ash.

Abrasive quality of the ash depends to some extent on the completeness of combustion. Instances are known in which the fan pressures and velocities have been about the same in two plants, one being practically free from erosion while the other showed considerable wear. Various metals have been tried, but so far none has proved more effective in resisting this wear than ordinary steel plate.

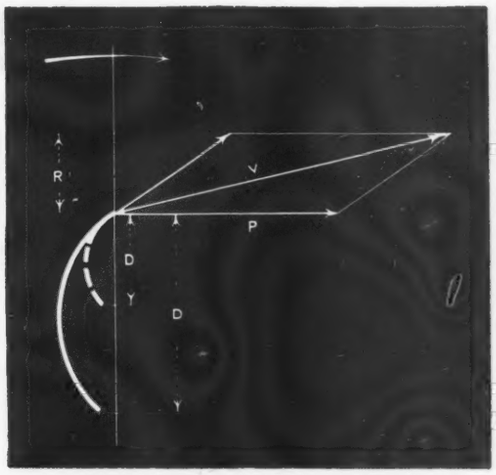
To withstand erosion, wheel blades are sometimes provided with heavy wearing plates where the greatest erosion occurs. Housings are provided with easily renewable scroll liners. Inspection doors, the full width of the fan housing, afford easy access.

Design is an important factor in the susceptibility of a fan blade to erosion. Figs. 1 and 2 show the blades of the forward and the backward curved types with their corresponding parallelograms of velocity. Both of the above forms of blade are subject to powdered coal ash wear, the greater wear occurring on the design that has the greater velocity of gas at the blade tip.

The static pressure produced by a centrifugal fan equals the pressure produced within the blade itself, due to centrifugal force, plus the static pressure converted in the volute housing from the velocity of the air leaving the blade tip. The greater the forward angle at the blade tip, the greater will be the leaving velocity and the greater the static pressure converted.

Let us compare the two blade types shown, each delivering the same capacity at the same pressure and having the same diameter wheels. In Figs. 1 and 2, P and P' represent the peripheral velocity of the tip of the blade, R and R' the radial velocity of the air through the blade. V and V' show the resultant velocity of the air leaving the blade. The static pressure converted from this velocity varies as the square of the velocity. The depth of blade D is the same as that of D'. At the same tip speed, the pressure produced within the blade due to centrifugal force would be the same.

The blade in Fig. 1 produces 1 in. static pressure at 2,700 ft. per min. tip speed. Of this, 0.3 in. is produced within the blade by centrifugal force and 0.7 in. is converted from velocity V. The blade in Fig. 2 is operating at 4,000 ft. per min. tip speed and, therefore,



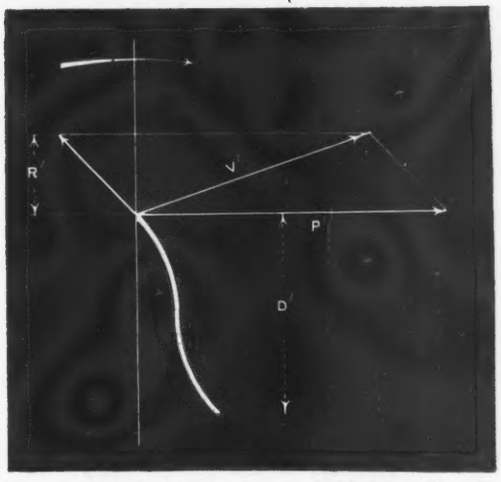


Fig. 1 (Top)—Forward-curved blade. Fig. 2 (Bottom)—Backward-curved blade

produces $\left(\frac{4000}{2{,}700}\right)^2 \times 0.3 = 0.66$ in. pressure within the blade. The relative velocity, V to V', is as 1 to 0.698, so that pressure converted from velocity V' will be $(0.698)^2 \times 0.7 = 0.34$ in., making 1.0 in. static for blade II.

It will be noted that blade I operates at lower speed than blade II on account of the higher velocity of the air at the tip of the blade. Conversely, the air in contact with the tip of the backward curved blade is at lower velocity than in the case of the forward curved blade, although its actual tip speed is greater. Actually, depth D of the commercial forward curved blade is considerably less than the depth of the backward curved blade, so that the difference between V and V' will be even greater than shown in the above example.

Some have assumed that wear would be less on a forward-curved blade on account of its lower tip speed. The opposite, however, is true, and by referring to the parallelograms of velocity it will be seen that the air velocity along the blade tip, and consequently the ash velocity at this point is greater than in the case of the backward curved blade operating at same capacity and pressure, and wear will be proportionately greater. For the same design of blade, it is true that the wear will be greater when tip speed is higher. The comparative wear on two different blade designs cannot be found by comparing tip speeds. Actual air velocities at blade tips must be compared.

POWER-PLANT PAINTING

WHAT YOU SHOULD KNOW ABOUT IT—1

By E. J. TANGERMAN
Assistant Editor

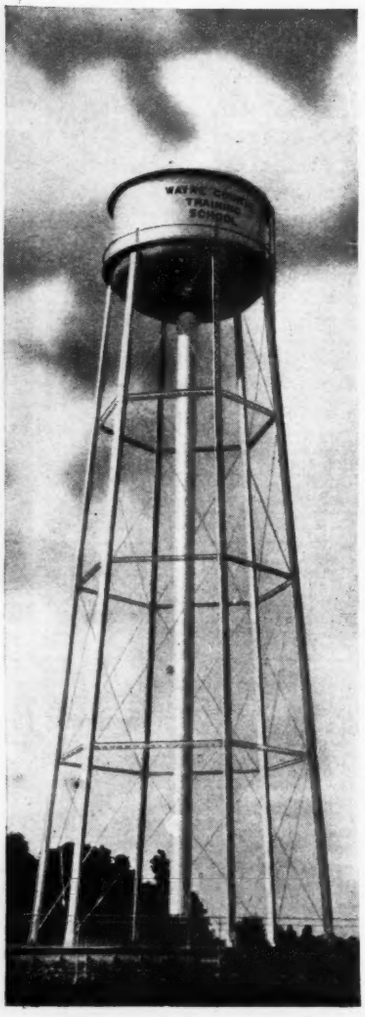
"Save the surface and you save all." This familiar slogan involves many factors in power-plant painting. In this and the concluding article, these factors are evaluated

PAINTING, often less than 3 per cent of total maintenance cost in a power-plant, is frequently not given the attention it deserves. But painting is protection, a means of definite money savings, an aid to working and an aid and means of saving in lighting. Without paint, concrete surfaces wear away, wood surfaces rot, metal surfaces corrode, and the ultimate repair bill is many times the cost of good paint properly applied.

Paint failures are caused usually by one of three things—poor paint, poor application, or improper surface conditions. Paint may be good yet highly unsatisfactory—for no paint can be satisfactory if used in the wrong place. Of course, there are also "bargain" paints that are useless on any job. After all, application cost is usually 70 per cent or more of the total, so the saving on "bargain" paint is negligible. Further, the cost of properly repainting an improperly painted surface is much greater than the original painting cost.

Any paint's capacity for service depends largely upon how it is applied. The paint should be brushed out well, particularly over rough surfaces, to force it through any extraneous film and into surface irregularities to assure good contact and uniform depth of coat. Too thick a coat will wrinkle, making repainting difficult; too thin a coat wears rapidly, exposing the surface.

Paint may also be applied by spraying, this usually being faster and more economical of paint. It does, however, require a lot of skill on the part of the operator. Proper balance must be maintained between paint and air volumes, air pressure and distance of nozzle from surface. It goes almost without saying that an operator should be required to spray a test panel before being allowed to coat actual surfaces.



OUTSIDE AND INSIDE

Painted with aluminum paint, composed of a special bituminous vehicle mixed with aluminum powder, this tower braves the elements. Inside surfaces, often neglected, are one of the places where corrosion takes its greatest toll. The painting material must effectively protect the metal, yet neither impart taste or odor to drinking water nor cause fumes injurious to painters. Certain synthetic resin paints, and special bituminous paints, have proven most satisfactory for water-tank interiors.

Photos courtesy Quigley Co., Inc.

Too much paint applied by spray causes wrinkling. Too little air causes poor atomization of the liquid and uneven coating. Too low a pressure fails to force contact between surface and liquid. Too much air drives the paint into a mist, causing poor films and loss of paint. Surface conditions encountered vary with the material; these are discussed later.

Three general characteristics should govern the selection of a paint: protection, saving, and appearance, which also includes lighting.

Protection

Sulphur fumes, chlorine fumes and similar vapors are very hard on paints. Humidity, excessive heat, extreme dampness under cool conditions, all affect the type of paint to be used, as well as the surface to be coated. Alkalinity in masonry walls, inherent moisture in timber, mill scale and rust on steel, all must be neutralized and corrected as far as possible *before* painting is attempted. Many paint companies now render definite engineering service along these lines, and they should be consulted if special problems are encountered.

In general, no paint with a high percentage of linseed oil as a base is satisfactory for use in the presence of continual moisture, when constantly submerged in water, or when in the presence of excessive acid or alkali fumes. Bituminous-type paints are much better for this service. Some of the special paints and lacquers, such as the glyptols, pyroxylins, amberols, etc., are also adapted for this purpose.

Protection should be considered in two ways: Protection against continued inherent disintegration (under the paint surface), and protection against exterior or atmospheric conditions. Usually, an undercoat must

be put on before paint. Impregnating pits is essential. Undercoats have no value as protection against exterior conditions, but are vitally important as protection against inherent disintegration.

Saving

Saving, the second item, is usually a function of the first—for power-plant owners want maximum protection at minimum cost. The lowest-priced paint that will do the job right is the one to be selected—often a low-priced pitch-base paint which stands temperature changes without cracking and has greatest penetration is better than a very expensive enamel. Another saving is in application. Some paints have five or ten times the penetrative power of others, hence can be applied with one sweep of the brush, while others must be brushed five or six times to make them adhere properly. To obtain low inventories, with their advantages of lower cost, it is best to choose one paint that can be universally used rather than several different ones.

A paint should wear through chalking, rather than chipping, flaking, or peeling, for the chalking surface is self-cleaning and also presents a good surface for repainting. Since it chalks away, the paint film never becomes so thick that it breaks loose, even under repeated painting.

Cement surfaces that are unpainted often give off sand, metal surfaces rust. This is an added argument for painting, particularly if the sand or rust will affect materials in process. Clear pyroxylin lacquers may prove best in this case—for usually, even if the lacquer should chip off slightly, it will not affect the material being processed.

Painting for Better Seeing

It is an admitted fact that proper lighting improves working efficiency from 10 to 25 per cent. Proper lighting, of course, includes proper painting, because only when paint is properly applied is lighting brought to its maximum efficiency. Further, light-colored surfaces also increase cleanliness, both in appearance and because they inspire workmen to keep them clean. Hence the old, old trick of painting floor corners white.

White paint on walls and ceilings is usually a very effective way to improve lighting in an old power plant. Light tints based on white, however, give a feeling of coolness, particularly if they are light greens or blues. Reds convey a feeling of heat, hence should be avoided. Lighter colors and proper surface finish also aid in reflecting light, aiding particularly in lighting dark corners about bunkers, fans, ductwork, etc. Absurd as it may sound, they also lessen fatigue and strain of operators, avoid glaring lights, and tend to keep the operator more concentrated on his work.

Reflection factors of painted surfaces vary over a wide range, depending on color. Average reflection values of commonly used tints and shades are:

Color	Per Cent of Light Reflected
White, new	82-89
Cream	73-78
Ivory	62-80
Buff	61-75
Light Green	49-66
Yellow	48-75
Gray	36-61
Light Blue	34-61
Pink	30-46
Dark Tan	17-63
Dark Red	13-30
Dark Green	11-25
Light wood varnish	42-49
Natural wood, brown stain	17-29

One enormous stride in painting practice was the introduction of interior gloss and egg-shell whites of non-yellowing character. Ordinary pigments in raw linseed oil turn a light saffron under exposure, particularly in humidified rooms, thus losing a large part of their light-reflecting power. Newer paints, usually lithopone or zinc-white paints, with new vehicles, do not discolor, even in sulphur fumes.

One good color combination is a colored floor, white or light-colored walls, ceilings white or light cream. Pale tints—usually those most closely approaching white, cream and ivory and of high reflecting value—are coming into greater use.

Light reflection depends mainly upon the ceiling and upper walls. The dado is usually darker to avoid soiling from operators' hands and clothes. Light reflection near the floor is not so important, so the dado may be gray, light green or buff, and from 4 to 5½ ft. high. Gray, unless it is a tint just off white, is very much lower in light-reflecting value than white or other light tints with white base, but discolors much less under oil and coal smoke. Black graphite paints are also commonly used, but absorb light.

Surface finish should be mat (unglazed) for uniform light reflection. Glazed or glossy surfaces result usually in uneven distribution of illumination.

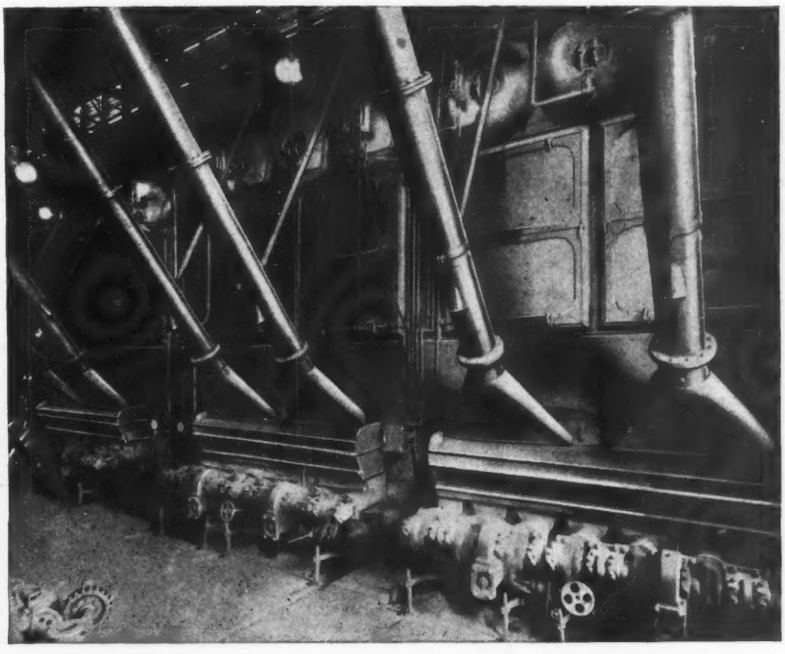
★

Ontario Hydro-Electric Power Commission is undertaking a water power development on the Albany River, far northern territory, to provide for the Central Patricia Mine and adjoining properties. This development will be the only one in that section, with the exception of the Ear Falls development. These developments will eventually be linked up with the Wahnapitae and the Abitibi in a provincial power enterprise.

★

BOILER FRONTS AND BREECHINGS

Engineers frequently have exaggerated ideas regarding actual temperatures on boiler fronts, stacks, breechings, etc. Ventilation keeps surfaces relatively cool, rarely over 500-600 deg. F. Special paints for this service have heat resistance and physical stability, and are usually bituminous or hydrocarbon types.



WORLD'S LARGEST DIESEL STATION

ADDS 13,700-HP. UNIT

LARGEST diesel station in the world is the 37,500-hp. plant providing electric energy for the French Concession in Shanghai, China. Sulzer Bros., of Winterthur, Switzerland, have just supplied one of the largest diesels so far built, a 13,700-hp. double-acting air-injection unit, to bring station capacity up to 51,200 hp. Current is used principally for lighting and for street railways, causing abrupt fluctuations and high peaks in the daily load curve. The eight single-acting engines and the new double-acting engine provide unusual flexibility in meeting these demands, and capacity can be increased in economical increments.

Similar in design to smaller Sulzer diesels, the new engine has a continuous output of 11,400 b.hp. at 136 r.p.m. It is an 8-cyl., 30x47.2-in unit, direct-connected to an 8,000-kw., 5,200-volt, 50-cycle, 3-phase, alternator.

Because fuel has high asphaltic content, air injection was adopted. Injection air is supplied by two 3-stage compressors, scavenging air by a double-acting tandem pump, all integral with the engine.

Fuel is introduced to the upper combustion space through a central fuel valve, at the lower end through two pockets in the cylinder head. The upper head is a solid of revolution, held down on the block by a steel ring and bolts. Safety valve and pneumatically operated starting valve are also in the lower head. All valves have vertical axes to avoid uneven wear, and are easily accessible. The camshaft is on the exhaust side, at about half engine height, and driven by screw gearing from the crankshaft at its center. Fuel valves are tie-rod operated, their lift being automatically regulated, in accordance with load, by a mechanism which varies position of the roller link in relation to the cam.

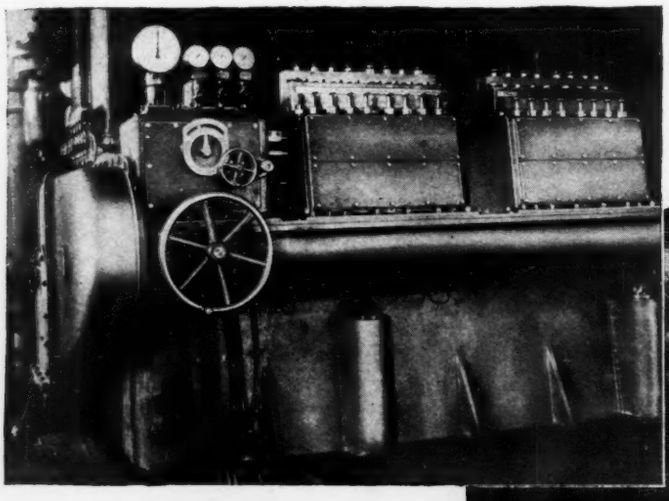
The main piston, Fig. 4, consists of three parts, the top and bottom parts being bolted, together with the cast-iron sleeve, to the piston-rod flange. The piston rod is joined to the crosshead with special opposed nuts which permit simple adjustment of compression and even distribution of stresses. An exterior hard cast-iron sleeve protects the rod from wear or contact with hot gases, and is fastened to the rod at its upper end only, the lower being free for expansion. Piston cooling water enters through this annular space and leaves by an axial passage in the rod. No contact with the rod occurs, however, because the rod is surrounded and lined with protective tubing. Cooling of the outer sleeve with water keeps the suffing box cool, therefore lubricated and gas tight.

Ports in the lower combustion chamber cause air to descend in a united stream on the admission side, to pass the rod near the cylinder head, then to rise to the exhaust ports, sweeping combustion pockets at the same time. The course of the gases is shown in Fig. 3. Analyses of cylinder contents have shown scavenging efficiency of 96-97 per cent, depending upon load, as high as that for the upper chamber.

Separate fuel pumps serve the upper and lower chambers. Pumps are arranged in two sets of eight, for upper and lower chambers respectively, and each has its own eccentric drive and regulating mechanism. Fuel is delivered to the valve early in the combustion stroke, remaining there until admitted. Quantitative regulation is effected by the governor through varying stroke of the suction valve. Each pump can be put out of action individually by a small lever, and its regulating, safety cut-out and control shafts each act independently on the suction valves. Priming is effected by hand lever.

One man can put the engine into service in 1½-2 min. from the central control station, Fig. 1, at the front of the engine. Starting and injection air bottles and cooling-water valves are also grouped here. Above is the load indicator, revolution counter and pressure gages for air, water and oil. A small handwheel permits adjustment of air-compressor delivery for special purposes (i.e., filling air bottles after starting). By this means, the automatic suction throttle valve regulating mechanism, joined in the fuel-regulating system, is modified. Fuel pumps are next the control station also, drive being transmitted by spur gearing. The hydraulic governor is on the engine framework near the fuel pumps.

The engine is controlled by a one-direction handwheel, an indicator showing positions. One turn from rest admits starting air and opens the injection air stop valve, turning the engine over. The next turn causes fuel to be delivered to the upper cylinder ends, and these begin to



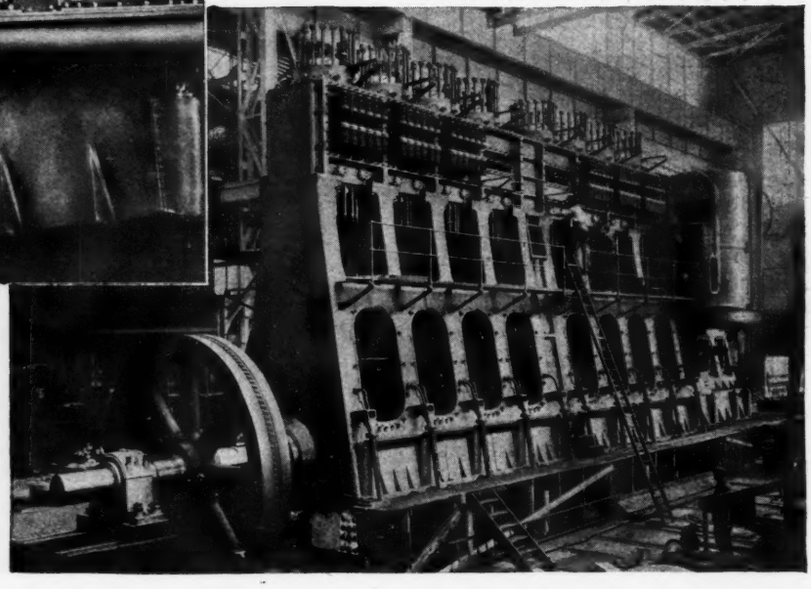


Fig. 1 (Left)—One man can put the engine into service in 1½-2 min. from this central control station at the front of the engine. Fig. 2 (Below)—An erection view. The engine completed was shown on page 111, "Power," February, 1934

fire. Further turning of the handwheel cuts off starting air and delivers fuel to the lower cylinder ends. Normal starting air pressure is 425 lb. per sq.in., but half that is sufficient to start up. To stop the engine, two further turns are given to the handwheel, putting fuel pumps out of action, cutting off injection air and venting piping.

Increasing power of diesels and more general adoption of the double-acting principle, with consequent greater resistance to governing, have made it essential to provide more positive action than mechanical governors provide. Thus a governor utilizing a servomotor becomes necessary. For the exacting conditions of parallel working, which the multi-cylinder double-acting engine with its small cyclic irregularity fully satisfies, a high degree of sensitivity and rapid operation are required of the governor. It can be adapted easily to varying service conditions because of its flexibility. The arrangement is simple, consisting essentially of a pump driven directly from the crankshaft, delivering oil at pressure varying with engine speed, and a servomotor acting on the engine regulating mechanism (i.e., fuel-pump by-pass valves, fuel-needle lifting gear, and air-compressor throttle).

In the governor, pump rotor *A*, Fig. 5, delivers oil under pressure below control valve *B*, at *a*. The upward force is counteracted by spring *K* and oil pressure on surface *b*. The sliding control valve therefore tends to take a position of equilibrium. Edges *c* and *d* control oil flow to and from surface *e* of servopiston *C*, increasing pressure under the seropiston when the control valve descends and vice versa. When control valve *B* is in its middle (neutral position, the oil under the servopiston at *C* is enclosed and the piston remains in the position taken up until control valve *B* is moved by a fresh governing impulse. Equilibrium of the servopiston is maintained by its weight and by constant oil pressure acting on surface *f*.

Dimensions are ample to overcome all reactions to governing influence. When, for example, engine load is reduced, governing action commences with an increase of the oil pressure delivered by the pump

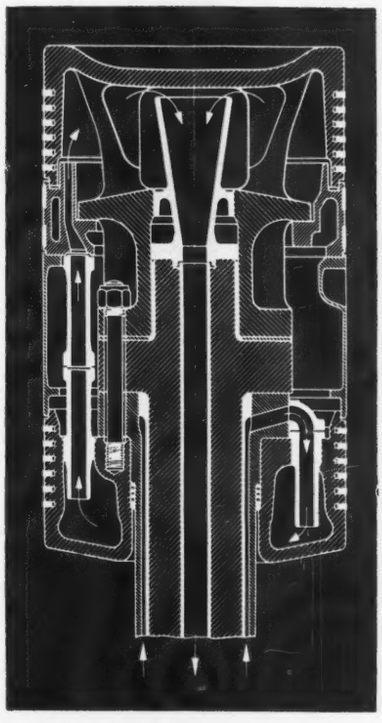


Fig. 4—Piston cross-section

rotor as a result of the greater crankshaft speed. This increase of pressure causes the control valve to rise, releasing oil from under servopiston, *c*, which falls. The fuel quantity injected into the cylinders is thus reduced until it corresponds to the new load on the engine, for in falling, the servopiston increases tension of control valve spring *K*, through the medium of lever *D* pivoted at *E*. Thus a new state of equilibrium is attained with the control valve again in its neutral position.

Assisting this mechanical return motion is a hydraulic stabilizing action which damps when throw is large. In governing as above, oil is displaced by surface *g* of the falling servopiston to exert pressure on flange *b* of the control valve, the two chambers being joined together and with the speed-adjusting device. The effect is to move the control valve back to neutral, pressure in the hydraulic return-motion system being determined by the spring tension of the speed-adjusting device. Increased tension of the spring, adjustable by means of a handwheel or remote control, raises oil pressure and causes the servopiston to rise. Engine speed accordingly becomes greater, with a corresponding increase of pressure delivered by the oil impeller, restoring equilibrium through the control valve. Similarly, reduced tension of the spring causes engine speed to fall off.

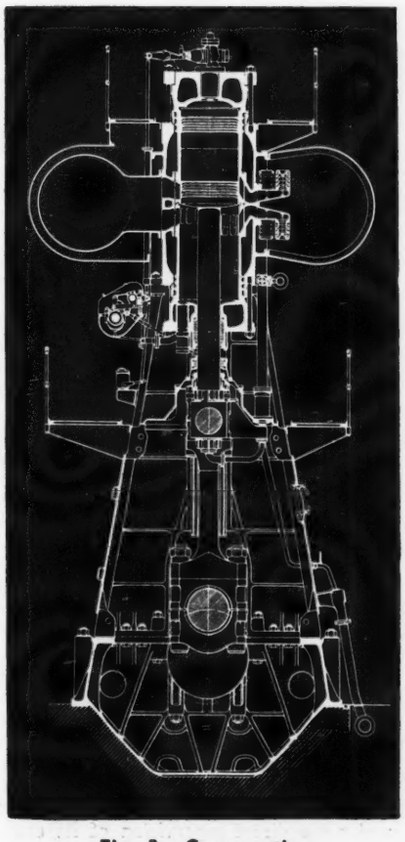


Fig. 3—Cross-section

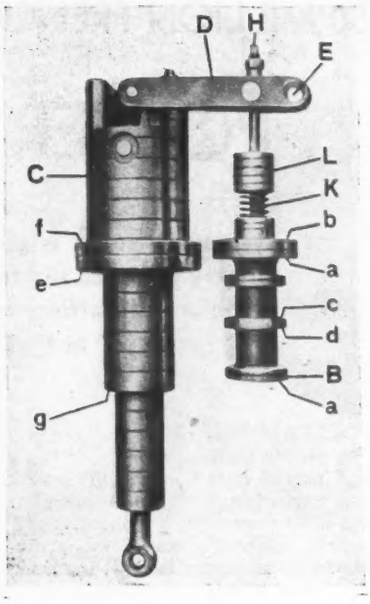


Fig. 5—Governor mechanism

Control piston valve *B* moves in a bushing with suitable ports which is mechanically vibrated through several thousandths of an inch. This constant pulsation is transmitted through the oil to all governing members, largely eliminating frictional resistances and thus effecting higher sensitivity. Since forces are directly transmitted by fluid pressure, no loss of accuracy can occur through joint backlash.

Scavenging air is drawn in through two receivers in series, baffles being incorporated for silence. Fresh water only is used for cooling, circulation being liberal (1,320 g.p.m. for cylinders and compressors, 710 g.p.m. for pistons) to avoid any summer high-temperature difficulties. A cooling tower is used to keep down water consumption. The two circulating pumps, one for cylinders, the other for pistons, are driven by the same motor. A duplicate pump set serves as standby.

Lubricating oil is led from the engine sump to a triple filter, elements of which can be removed and cleaned while running; thence to the gearwheel pump and through the oil cooler back to the engine. There is also a special centrifugual oil-purifying plant, through which sump oil is passed regularly. One advantage of the double-acting engine is the absence of oil contamination through residual products of combustion, since stuffing box and oil separate combustion chamber and crankcase.

The engine can be run on light or heavy oils. There are two fuel storage systems, that for heavy oil being provided with heating. Change-over from one fuel to another can be effected from the engine control station. Fuel is pumped from the storage tanks outside to the reservoir in the engine building, from which it flows by gravity through filter vessels with floats to the fuel pumps. The engine is set lengthwise of the station, with the generator on the inner end, thus allowing room for another engine of the same size on the same axis. This arrangement, with alternators in the middle, results in symmetrical static loading of the foundation and reduces free dynamic forces due to torque reactons.

50 MILLION FRENCHMEN CAN'T GO WRONG WITH U.S.-DESIGNED

POWER FOR FRENCH REFINERY

By-product power is generated from process steam for refinery purposes and for power-plant auxiliaries in the new plant of Raffineries de la Vacuum Oil Co., S.A.F., at Port Jerome, France

STEAM, electricity and compressed air for the new refinery of the Raffineries de la Vacuum Oil Co., S.A.F. are supplied from its own power plant on the refinery site. The refinery is at Port Jerome, France, about 30 mi. above Le Havre on reclaimed land on the banks of the Seine River. The two 2-stage distillation units of the refinery will handle 6,600 bbl. of crude oil per day. Power for refinery purposes and for power plant auxiliaries is generated as a by-product of process steam since the steam for use in the refinery is first put through turbines. In addition reducing valves are installed to provide steam in the event process-steam demand overbalances power demand. Likewise, a condensing turbine is installed to provide additional power when electric demand is greater than can be supplied from process steam.

Three turbines are installed, with provision for two more units when the load requires. A 1,250-kw. turbine receives steam from the boilers at 250 lb. pressure and exhausts into an intermediate-pressure header in which 142 lb. is carried. Some of the intermediate-pressure steam is used in the refinery; the remainder passes to an 825-kw. turbine-generator which exhausts at 23 lb. back pressure. This exhaust steam is used in the refinery and for heating. Steam-driven auxiliaries of the power plant also exhaust to the 23-lb. system. The 1,000-kw. condensing turbine carries load fluctuations and meets the power demand in excess of that produced by process steam. The reducing valves are arranged to provide intermediate-pressure steam from the 250-lb. header and low-pressure steam from the intermediate-pressure header, thus bypassing either or both back-pressure turbines. Turbine-generators operate at 3,000 r.p.m.

Excitation of the 5,500-volt main generators is provided by two turbine-driven units operating at 1,500 r.p.m. One of these units is arranged for dual drive with a synchronous motor. Voltage regulators are installed.

Boilers

Three boilers are now installed, with space and stack for a fourth. They generate steam at 255 lb. pressure and 662 deg. F. and each has a normal capacity of 75,000 lb. per hr. and maximum capacity of 99,000 lb. per hr. Steam temperature was selected to give dry or slightly superheated steam at the far end of the intermediate-pressure line. This also gave reasonably dry low-pressure steam.

Each unit comprises a cross-drum boiler with 5,400 sq.ft. of heating surface, an air preheater with 2,800 sq.ft. of surface and an economizer with 6,890 sq.ft. of surface. The whole unit was designed for burning refinery wastes (such as soda tar and acid sludge) with possible future use of pulverized coal. This necessitated unusual arrangements because of the corrosive nature of the products of combustion and the scale-forming characteristics of the products of combustion of acid sludge and soda tar when burned simultaneously.

The furnace is fitted with water walls protected by cast-iron blocks. Refractory was not used on the blocks because the soda tar and acid sludge make a flux that is particularly hard on refractory. Such refractory as had to be used in the corners and over the burners has a high aluminum content.

Burners

Three combination burners for each boiler are arranged so that they may be supplied with either fuel, but at no time can both fuels be burned simultaneously in any one burner. Normally, the two top burners are supplied with acid sludge while the bottom burner uses soda tar.

Sludge supply and return lines are of brass, and the pipes carrying tar are of steel. Valves at the boilers are interlocked so that sludge and tar returns cannot be mixed. Sludge is pumped by two turbine-driven gear pumps. Tar is supplied to the burners by two duplex steam units, the pump ends of which are of nonferrous metal. Automatic combustion control is provided and arranged to regulate either the amount of sludge or tar burned. Normally, the control regulates the sludge, and the tar burners are hand-controlled.

Because of the corrosive nature of the flue gas, the plate-type air preheater is between the boiler and economizer. It thus receives hotter gas than if placed in the more usual position after the economizer. The hotter gas raises the temperature of the metal, and there is thus less likelihood of its temperature falling below the dew point where corrosion would be severe. Because of its location, the air heater has a relatively small amount of heating surface; furthermore, only half the air goes through it, the rest being bypassed.

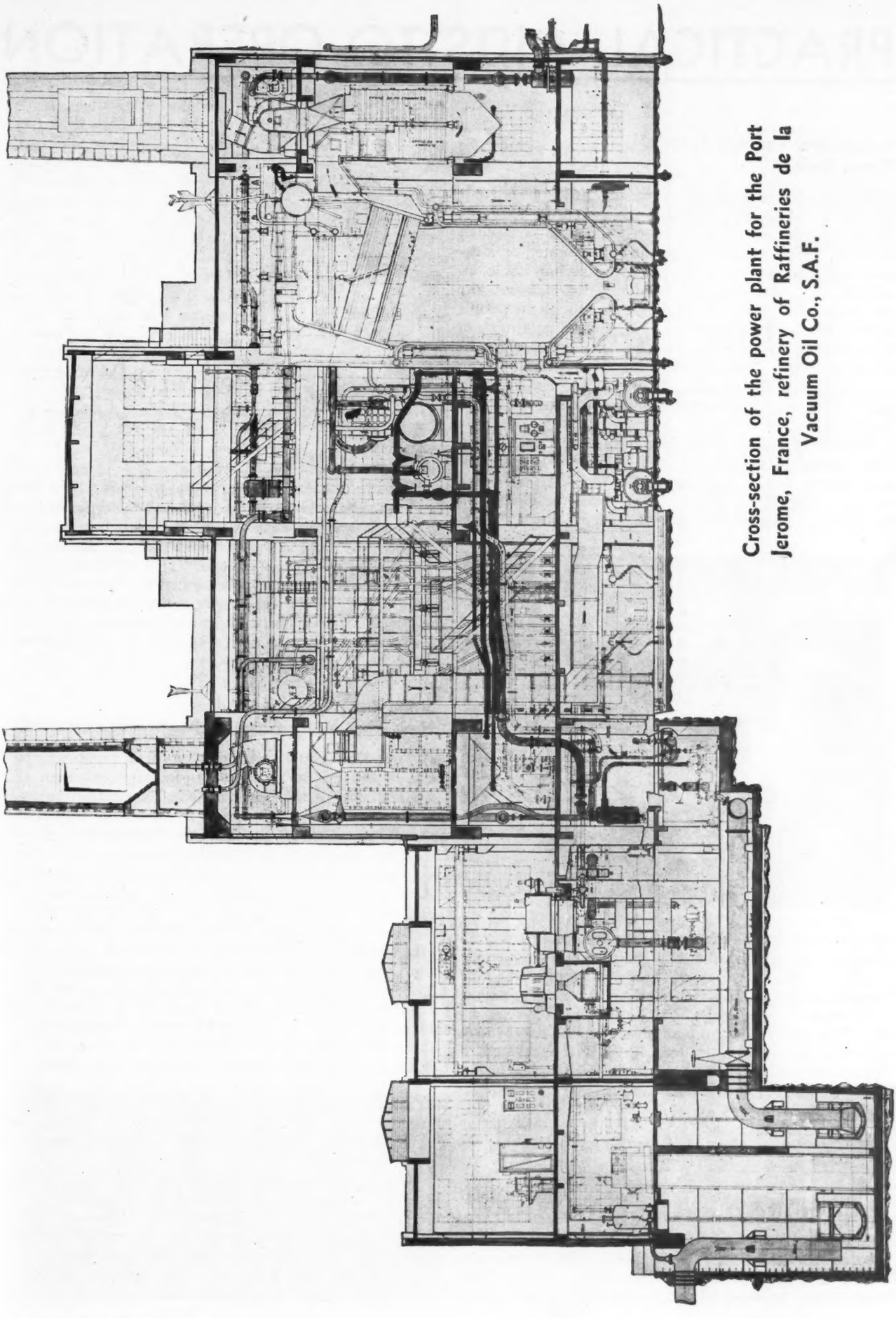
Extended-surface economizers could not be used because of the peculiar scale-forming characteristics of the flue gas due to the soda tar; therefore, smooth tubes were employed. To minimize corrosion, feedwater is heated to 250 deg. before going to the economizer. There is one induced-draft fan driven by two motors and one motor-driven forced-draft fan per boiler. The two stacks are supported on building columns and are built up of concrete blocks shaped to the hexagonal cross-section of the stack. The blocks are set one on top of the other and held in position by tie rods at the corners. Top of stack is 131 ft. above grade.

Well water is used for boiler feed, for, although there is little difference between it and the Seine River water, it is practically clean, while the river water contains a large amount of silt and vegetable matter. Feedwater is treated with lime and zeolite. Provision is made for the addition of coagulating treatment if Seine River water should be used for feeding the boilers later. An aeration tank is included where the alkalinity can be corrected with sulphuric acid. Equipment is installed for feeding phosphate direct to the boilers when necessary.

Water treatment at Port Jerome is of unusual importance, not only because of the poor quality of water available, but also because the boilers operate with almost 100 per cent make-up. Little condensate is returned as boiler feed, since most of the steam generated is used for process in the refinery. After being treated, boiler feed is deaerated under vacuum. Water is heated by direct-contact heaters to 185 deg. F., using steam from the 23-lb. pressure line. The feed then passes to surface-type heaters in the circuit between boiler feed pumps and economizers which raise its temperature to 250 deg. F.

To avoid building a separate pump house for refinery service water and for fire pumps, a battery of three service pumps and two fire pumps are installed in the basement of the turbine room. These pumps use Seine River water, drawing it from a pit located under one corner of the electrical bay. Two large syphons about 225 meters long provide the means for keeping this pit filled with water. Before entering the pump suctions, the water passes through rotating screens which remove dirt and debris. The capacity of each service pump is 3,170 g.p.m. Each fire pump has a capacity of 1,100 g.p.m.

Owing to decrees by the French Government, it was necessary to purchase for the refinery and power plant all equipment of French origin and manufacture. In the cases where it was not possible to find specified material or equipment in France, it was necessary to obtain governmental approval before placing the order abroad. The entire distillation and power plant was designed by S. A. Foster Wheeler, and all equipment was either built by S. A. Foster Wheeler or built under the direct supervision of its engineers.



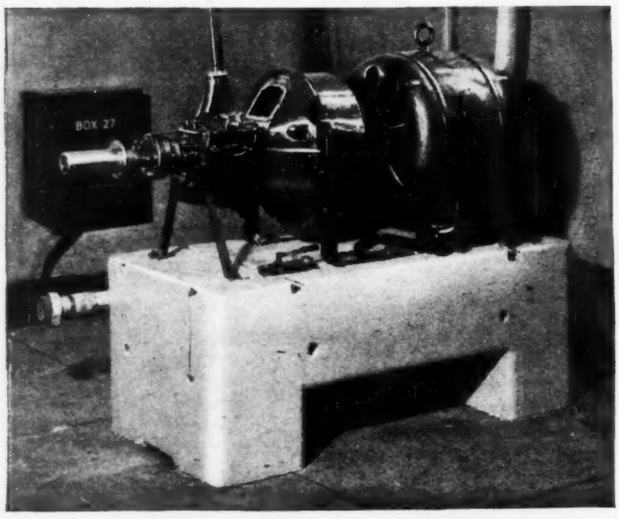
Cross-section of the power plant for the Port Jerome, France, refinery of Raffineries de la Vacuum Oil Co., S.A.F.

PRACTICAL AIDS TO OPERATION

A Portable, Variable-Speed, Power Unit

THE NEED of a portable, variable-speed, power unit prompted this design. Essential elements are a constant-speed induction motor attached to a transmission-clutch assembly (from an old automobile) all mounted on a reinforced concrete base. The base, measuring 50x26 in. x20 in. high, was poured so that the two ends support the block with a central portion high enough to permit a flat truck to be slipped under. Motor and transmission are mounted and held in place by bolts in tee slots set in the concrete. The concrete base is sufficiently heavy so that, except in unusual circumstances, no clamping down is required when the unit is connected to the driven machine.

The transmission gives four speeds for the driven unit; namely, 100 per cent, 26.3 per cent, 14.2 per cent and reverse at 11 per cent motor speed. The clutch permits changing speed without stopping the motor and the motor is started without load. Direction of rotation



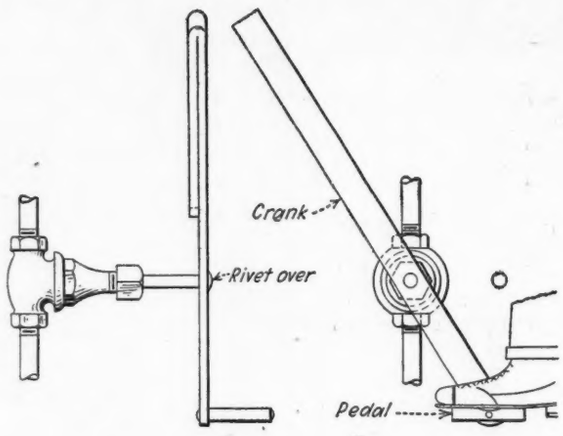
can be changed by interchanging a pair of motor leads when the reverse transmission speed is not satisfactory.

This power unit is used to drive pumps and fans brought in for test and for starting automobile engines which have been torn down and are stiff after reassembly. The stub shaft and a suitable coupling can be used to attach the unit directly to the driven machine. A flexible coupling was made from one of the universal joints obtained from the same automobile graveyard that supplied the transmission.

Bethlehem, Pa. J. H. JENNINGS
Lehigh University

Pedal-Operated Valve

RECENTLY, I came across a unique method of operating a valve near the floor. The machine, which the valve serves, at a certain part of its operation required both hands of the operator to manipulate the levers at a time



when the valve must be gradually opened and closed. To operate the valve the wheel was replaced by a crank and pedal, bicycle fashion, so it can be opened and closed by the operator's foot. The crank is made of a flat bar bent over at one end and riveted to the valve spindle, with the pedal at the short end. This off-balance weight is enough to turn the spindle so that the operator presses down on the down-stroke only, merely keeping his foot in contact as the pedal returns on the up-stroke.

Hamilton, O. H. MOORE.

Some Pump Troubles and How They Were Corrected

A NEW 3-in., double-suction, centrifugal pump was purchased for use with a water-softening equipment that required 300 g.p.m. against a 50-ft. head. After the pump was erected by the purchaser, it was found that it was about 100 g.p.m. low in capacity. Investigation showed that the pump had a 3-in. suction line about 200 ft. long; as a result the suction lift was about 27 ft. When the suction line was replaced with larger pipe to reduce the suction lift below 15 ft., the pump met the required conditions satisfactorily. If the purchaser had given the pump manufacturer complete information when buying the pump, the trouble could have been avoided.

In another instance, a 6-in., 1,000-g.p.m. pump operating under a suction lift of about 18 ft. did not come up to capacity. It was found that the lantern rings in the stuffing boxes had shifted so that the boxes were not being properly water-sealed. Air was being drawn into the suction chambers and causing a reduction in capacity. With the lantern rings set in line with the water-seal piping so that water could flow through the stuffing boxes and seal them against air, the pump delivered rated capacity.

A 2-in., close-coupled pump with an 11.5-in. impeller having a single shroud extending about halfway up the vanes was installed for handling a fairly viscuous liquid. After operating satisfactorily for several months, the pump began to lose capacity and pressure. It was found that the unsupported portion of the impeller vanes had bent back, reducing impeller diameter and changing

pump characteristics. To correct the trouble, a new impeller with reinforced vanes was installed.

Noise is one of the most difficult troubles to locate in a centrifugal pump. A boiler-feed pump to deliver 500 g.p.m. against 600-lb. pressure was equipped with a balance disk and seat of the conventional type for automatic hydraulic balancing. This type of construction had been used previously on hundreds of pumps satisfactorily. In this one instance, the impellers were made unusually large in diameter due to the low speed (1,450 r.p.m.). This, coupled with high pressures in the pump volute, prevented the balance disk and seat from functioning with their usual smoothness. The balance disk did not find a fixed running position, but moved back and forth, alternately opening and closing the space between the disk and seat, and produced an annoying chattering sound and vibration. This trouble was corrected only when the balance disk and seat were replaced by a balance drum of proper design.

A centrifugal boiler-feed pump designed for 1,500 g.p.m. against 400-lb. pressure at 1,750 r.p.m., broke its shaft after about 800 hours of operation. After we replaced the shaft, tests showed that because of the volute design there was a steady downward pressure on the shaft during operation, which flexed it and caused it to crystallize and break. A larger shaft would have corrected the trouble, but this would have required changing all the impellers and internal parts of the pump. Rather than do that, the pump manufacturer designed a new case with a double volute to fit around the same rotating element. In this way, pressure was distributed uniformly around the shaft, and prevented any further shaft trouble.

New York, N. Y. FRANK A. KRISTAL
Mechanical Engineer

Operation of Vacuum Pump Improved By Cooling Coil

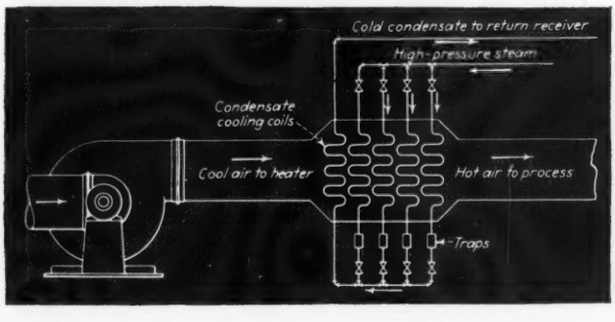
IN AN industrial plant, trouble was experienced in maintaining the proper vacuum on the condensate return system. To lower the temperature of the condensate at the receiver below the flash point corresponding to the necessary vacuum required for proper operation of the low-pressure heating system, a large quantity of cold raw water was added. The addition of this raw water caused an appreciable heat loss in that it was subsequently wasted by overflowing the boiler-room surge tank. Trouble was also experienced with the boiler feedwater treatment system because of the untreated raw water.

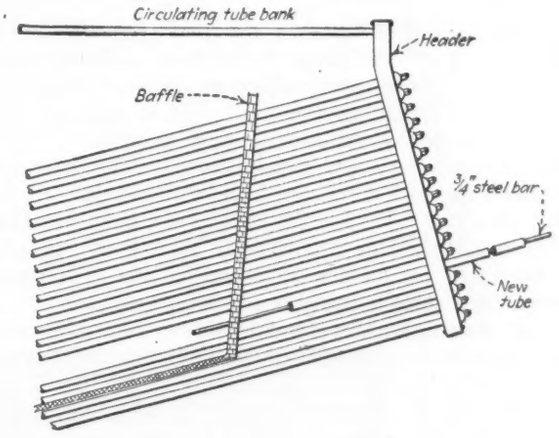
It was found that the traps on a large high-temperature air-heating unit used in a drying operation were discharging into the return receiver. To eliminate as far as possible the cooling water necessary to reduce the temperature in the receiver caused by the discharge of these traps, an auxiliary coil was installed in the air heater.

As shown in the sketch the discharge from the high-pressure traps was passed through this coil and cooled sufficiently to avoid further trouble with the vacuum on the low-pressure system. The temperature of the trap returns leaving the coil was low enough to eliminate all the raw water required in the receiver, and in addition, eliminated the heat loss from overflow of the boiler-room surge tank.

Waynesboro, Va. S. H. COLEMAN

Cooling coil lowers temperatures of trap discharge





Use Steel Bar as Guide When Replacing Boiler Tubes

REPLACING a leaky boiler tube is not an easy job at its best. Repair crews often find considerable difficulty in lining up the new tube with the hole in the baffle wall. With the heavy tubes as used in high-pressure boilers, there is considerable weight to support. Much time is taken in getting the end of the tube started through the first baffle.

This job can be simplified if, after the new tube is pushed through the header about halfway to the first baffle, a steel bar about ¾ in. in diameter and 5 or 6 ft. longer than the tube is passed through the inside of it. A man inside of the furnace can guide the bar through the baffle hole with comparatively little trouble. This bar will support the tube, which can be moved along the bar to the baffle. With the bar as a guide the job of getting the tube through the baffle will be considerably simplified, time saved and breaking of brickwork reduced.

Boston, Mass. CHAS. A. ARMSTRONG

"Dry Ice" Lowers Large Tank To Its Foundation

AN INTERESTING new method for placing heavy equipment has been used successfully by the engineer of a large ice-cream plant in New York City. The problem was to spot a 20-x13-x5-ft. rectangular welded-steel brine tank, weighing 6,500 lb., on a flat foundation. The tank was fabricated on wooden cribbing placed so that all parts of the tank were accessible for welding.

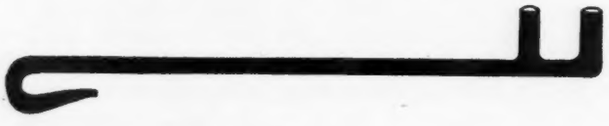
After welding, six blocks of "Dry Ice" (solid carbon dioxide), each 10x10x10 in., were evenly spaced on the foundation. The tank was moved approximately into place and lowered by jacks until it rested directly on the

Dry Ice. Friction between the tank bottom and the Dry Ice was so small that the former could be moved into position by one man pushing against it. After being positioned, the tank was then blocked to prevent shifting, and allowed to settle to its final position as the ice melted away. Dry Ice evaporates to a harmless gas, so that no trace of it remained under the tank.

It took about 5 hr, for the ice to melt, but the melting can be accelerated or retarded by heating or insulating the blocks of ice as the structure settles. High-grade Dry Ice will sustain fairly heavy loads per unit of supporting surface, but six standard blocks were selected as a minimum to assure uniform settling regardless of any variation which might be found in a single block.

The method is believed to be applicable to lowering all kinds of heavy equipment where space is cramped and where overhead crane facilities cannot be had.

New York, N. Y. C. L. JONES
American DryIce Corp.



Homemade Wrenches for Twisting and Straightening

MY GRANDFATHER always had a set of twisting bars on hand for twisting and straightening heavy hot and cold bar and flat-iron stock. They are among the most valuable tools around a power plant. Sometimes two 36-in. Stillson wrenches are used for bending and straightening iron and pipe; very often straining them by such abuse. The wrench shown in the diagram is of 1-in. steel, 4 ft. long, but I have one of 1½-in. square steel, 8 ft. long that will straighten out small cold-rolled shafting, such as in a plant wreck or bad breakdown.

Vancouver, B. C. S. H. COOKE

Maintaining Brushes on Rotary Converters

WE HAVE FOUND it good operating practice to keep a close check on the brushes of our rotary converters, especially those on the slip rings. On account of their high conductivity we are using soft graphite and copper brushes. These brushes expand considerably if overloaded and are likely to stick in the holders and throw more load on the brushes still free. In a short time there will be a damaged ring. Unless attended, a flashover may occur. At our automatic stations, one or two carbon brushes are used in each group of ring brushes, as these are not so likely to stick in the holders as the graphite-copper brushes.

When replacing brushes, we do not sandpaper them to the shape of the ring or commutator surface but add one or not more than two in each group of brushes at one time. They wear in perfectly in a few days. To sandpaper the brushes to a fit on the direct-current end would be a real job, for the commutator is covered with flash barriers that would have to be removed to do the job.

The soft alternating-current brushes wear considerably and the resulting metallic dust is removed frequently from all the insulating surfaces and from the inside of the brush-holders.

On the direct-current pilot brushes, it has been found that flashing when starting can be relieved considerably by reducing the brush thickness so it cannot bridge more than two bars at once.

Nashville, Tenn. THOMAS E. MILLER

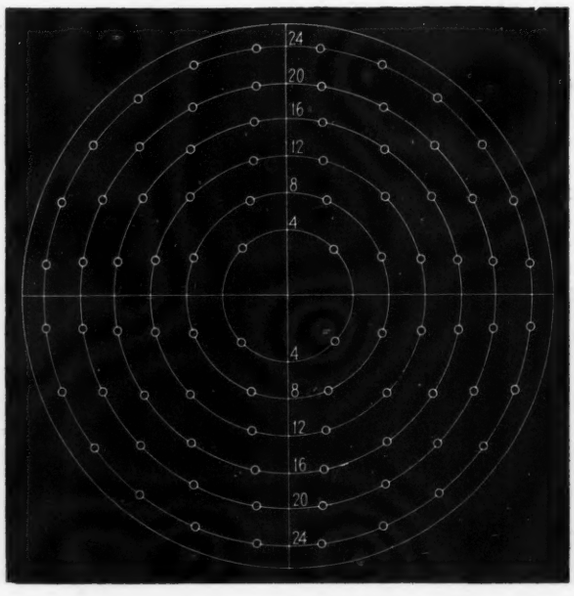
Handy Device for Laying Out Bolt Holes

A FRIEND, who makes many power-plant drawings, wanted a handy device to lay off bolt holes straddling the center lines, and to be able to lay out from 4 to 24 holes. I got a piece of transparent celluloid from a drawing material house and made the device shown in the figure. It has proved a time saver.

First, I laid out several concentric circles on brown paper with the necessary bolt spacings straddling the center line. I used constructed lines and angles in order to avoid the errors common to ordinary triangles. Then I fastened the paper to the celluloid and drilled through, using a sensitive drill and a $\frac{1}{32}$-in. bit. After all holes were drilled and the center lines matchmarked, I counterbored the holes with a larger drill point, just enough to take off the rough edge of the hole.

One has merely to select the circle with the proper number of holes and to mark the hole centers, through the celluloid disk, on the paper. Then by radial lines through the centers, the gage points are transferred to any bolt circle required.

Detroit, Mich. JOHN S. CARPENTER



CURRENT COMMENT

Who's Billed for Blow-Down

IN VIEW of the discussion over the relation of the heat recovered by a continuous blowdown heat exchanger to the efficiency of the boiler (*Power*, March), I feel that the basic reasoning underlying the formula given in my original article should be presented.

Segregation of the boiler and its function of steam generation from the steam-utilization section of a plant entails the measurement of heat supplied to the boiler both as heat in the fuel and heat in the feedwater, together with the measurement of the boiler output.

The efficiency of the boiler can then be expressed by $\frac{Ws\ (h_2 - h_1)}{W_f\ C}$ in which Ws is the quantity of steam in pounds as measured at the boiler outlet nozzle, h_2 the heat content per pound of this steam, h_1 the heat content per pound of the feedwater, W_f the weight of the fuel, and C its heat content per pound. This method of computing boiler efficiency takes into consideration all the waste chargeable to defective mechanical condition and poor operation of the boiler.

Let us consider the subject of feedwater conditioning and its place in the segregation scheme. The effect of impure feedwater on the efficiency of heat transfer within the boiler due to scale formation is well known. For the prevention of scale, protection of the boiler metal and to insure a good quality of steam, some method of conditioning this water must be resorted to.

When segregating the heat losses resulting from feedwater conditioning, an analysis must be made of the utilization of the boiler's useful steam output. In the utilization process, a portion of the heat in this steam is given up to perform the work for which the plant is operated. To secure the greatest efficiency from the utilization process, some of the useful boiler output is returned to the boiler. The boiler is charged for this return when the heat in the feedwater is considered in the boiler efficiency calculation. When charging the boiler for this heat return, we automatically credit the utilization process.

In a theoretically closed system, all of this water is returned to the boiler, and no additional water is necessary. It is practically impossible, however, to have such a closed system, and some of the pure water is wasted. As this loss occurs during the utilization process, this process, rather than the boiler, should be charged with the heat required to condition the raw water.

One method of providing pure make-up is by an evaporator. If we apply the formula for boiler efficiency, it is easily seen that the evaporator heat losses are charged to utilization rather than to boiler output, and the segregation of the boiler remains intact.

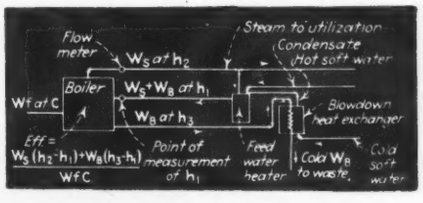
Over-all economy may dictate the use of water-softening systems or the chemical treatment of the raw water make-up within the boiler. In either case, it is necessary that we waste heat from the boiler by blowing down a certain percentage of the water in the boiler to avoid excessive concentrations of impurities. This loss of heat is chargeable to utilization. But this loss of heat is usually so slight that it is included in the boiler losses.

Now consider a plant in which a large proportion of the condensed boiler output is not returned. The raw-water supply has a high impurity content, and an analysis of conditions indicates the installation of external softening equipment, with some method of heat recovery from the resulting high percentage of blowdown. A diagram of such a system is shown in Fig. 1. Due to the large quantity of heat recovered from this blowdown, it is necessary, if we wish to maintain our segregation, that this heat be credited to boiler output, and utilization charged for all losses due to feedwater conditioning, as was done in the case of the evaporator. The formula for efficiency in my original article does this.

$$Efficiency = \frac{Ws\ (h_2 - h_1) + W_b\ (h_3 - h_1)}{W_f\ C}$$

in which W_b is the quantity of blowdown water in pounds, h_3 its initial heat content, and h_1 the heat in feedwater at the boiler inlet.

When calculating efficiency in this manner, all heat losses incidental to feed water conditioning are charged to the utilization process where they properly belong, rather than to the boiler. If we do not consider losses from the blowdown heat exchanger as utilization losses, we must consider the heat exchanger in conjunction with the boiler when calculating efficiency. In this case, all heat losses incidental to feedwater conditioning must be charged to the boiler. If this were done, we would be forced to correct boiler output for feedwater conditioning heat losses wherever such losses occur, whether it be through the medium of an evaporator, hot process softener, or blowdown heat exchanger. To segregate the boiler for the purpose of efficiency comparisons under such a scheme would, in the majority of plants, be a complicated proceeding.



In this connection, consider a boiler generating wet saturated steam. The water present in the mechanical mixture is entrained boiler water, or a form of blowdown. When considering this steam as useful boiler output, the heat content of the entrained water is considered in the calculation of h_2. In this case $h_2 = h_4 - \frac{(L \times M)}{100}$ in which h_4 is the total heat of dry saturated steam at the boiler outlet pressure, L is the latent heat in the steam at this pressure, and M the percentage of moisture in the mixture. This relationship may be broken down in terms of steam and water, and if used in calculating boiler efficiency, becomes:

$$Efficiency = \frac{Ws\ (h_2 - h_1) + W_b\ (h_3 - h_1)}{W_f\ C}$$

in which Ws is the actual dry steam generated in pounds, and W_b the moisture in pounds carried over with the steam at saturated steam temperature. In this instance, carryover or blowdown is considered as part of the useful output of the boiler. I can see no reason why, if this is true, that blowdown water passed through a heat exchanger should not be so considered.

Waynesboro, Va. S. H. COLEMAN

VARIABLE-PRESSURE OPERATION

WITH THE BENSON BOILER

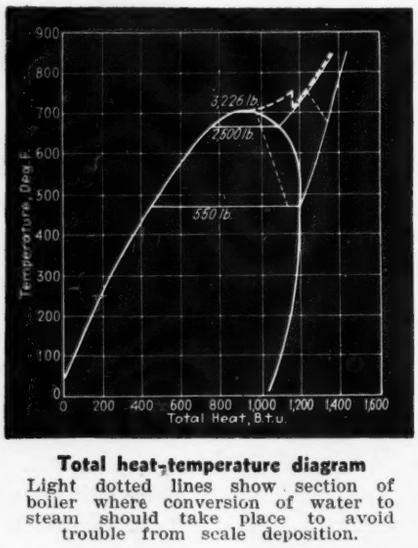
By F. OHLMULLER[1]
Graduate Engineer

THE Benson boiler was developed to operate at the critical pressure, 3,226 lb. per sq.in. and 706 deg. F., under which condition water turns completely and instantaneously into steam, and without change of volume. Separation of steam from water, such as takes place in the drums of ordinary boilers, is therefore, not necessary, and dry steam may be produced in tubular boilers without drums. In the first Benson boilers, no difficulty was experienced in distributing the flow among the tubes, which were connected in parallel. However, burning-out of tubes did occur after the boiler had been in operation for some time. It was found that the burning-out was caused by precipitation of the salt contained in the feed-water in those parts of the tube where the water changes into steam. In the early Benson boilers, this conversion zone was placed in the region of maximum intensive radiation to secure counterflow. This difficulty was overcome by removing the conversion zone from the furnace radiation zone to a region of lower flue-gas temperature.

Steam boiler plants have always been operated so as to maintain steam pressure constant, and as near to the maximum pressure allowed by the boiler design as is conveniently possible. At the suggestion of Mr. Gleichmann, Siemens-Schuckert developed a new method of power plant operation which omits the throttling of steam between boiler and turbine. In this system, the boiler always delivers steam at the most economical pressure consistent with the load at which the turbine has to be operated.

Experience gained in operation at the critical pressure has been applied to the operation of Benson boilers at pressures below the critical. Tests have shown that here also, as in the case of critical pressure, the difficulty lies in the formation of salt deposits in a certain zone of the heating surface. It was found that this zone is at a point at which evaporation terminates and superheating begins, and is clearly restricted to a limited portion of the boiler heating surface. Here again, the remedy was to shift the zone of deposit to a region of lower flue-gas temperature.

The feasibility of operating a Benson boiler at variable load and pressure is illustrated by the total heat-temperature diagram. With varying load and pressure, distribution of heat in the various sections of the boiler heating surface should be such as to insure that those surfaces subject to deposition of salt remain in the region of low flue-gas temperature. The conditions obtaining when the boiler is operated at critical pressure are shown by the heavy dotted line. Following the saturation curve, the water at critical pressure is brought up to the critical temperature and then superheated beyond that to about 750 deg., whereupon the steam is throttled down to 2,500 lb. pressure and again superheated to 850 deg. This was the method of operation before the boiler was operated at sub-critical pressures. The full lines show the working of the boiler at lower pressures. Depending on the pressure, the curve remains more or less within the region of saturation. The region where the bundle of tubes is situated, and in which the conversion of water to steam takes place, is shown by the thin dotted lines. It will be seen that even though the pressure varies, the saturation curve always remains approximately in the middle of that region.



Total heat-temperature diagram
Light dotted lines show section of boiler where conversion of water to steam should take place to avoid trouble from scale deposition.

This method of operation was first tried out at the Siemens-Schuckert cable works, where a Benson boiler has been in service for over a year. The turbine valve is kept open all the time, irrespective of the load. Boiler pressure is adjusted to force enough steam through the turbine to carry the load. At this plant the load has on several occasions dropped from 52,000 lb. per hr. to 22,000 lb. per hr., and afterward come back to its original value. Under these conditions, the pressure dropped from 2,000 lb. to a minimum of 700 lb. per sq.in., and rose again as the load increased.

Operation at varying pressures can be utilized to particular advantage in power stations operating with fluctuating loads, especially where peak loads have to be met. In such cases, the turbine could be designed to take the most frequently occurring base loads at the lowest economical pressure, and when peak load comes on the steam pressure can be correspondingly increased so that the weight of steam passing through the turbine is similarly increased. The volume of steam passing to the turbine will remain constant, since at constant inlet temperature the specific volume is approximately inversely proportional to the pressure.

Thus, a condensing turbine, designed for 500 lb. pressure, 850 deg. F., and a good vacuum, can pass approximately 4.5 times the weight of steam without altering the position of the stop valve, if the pressure is raised to 2,000 lb. per sq.in. The adiabatic and useful heat drop under the two pressure conditions is approximately constant. Since the total volume is also constant, and the Parsons factor of the machine remains practically unchanged, it follows that the thermodynamic efficiency of the machine, consequently its specific steam consumption, is also constant at all loads. Governor valves are unnecessary for the turbine if it operates in parallel with other machines. All that is required is a stop valve designed for quick closing in case of emergency.

Industrial Plants

Operation at variable pressures would also be of advantage in industrial plants where the amount of process steam required in relation to the power required by the plant may change considerably. Thus, when the amount of steam called for by a manufacturing plant is large in comparison with the electric demands, pressure on the boiler can be dropped to 500 lb. If, however, process requirements decrease and the electric load goes up, steam pressure can be raised to 2,000 lb. and all of the electrical energy needed by the plant still generated as by-product power. For example, consider a turbine bleeding steam at 400 lb. pressure, 625 deg. F., operating against a back pressure of 60 lb. If the maximum quantity of steam with which this turbine can deal is no longer sufficient to generate the electric power required, it is possible to increase the ouptut by 30 per cent (as compared with the previous output at low pressure) with the same quantity of steam by raising the inlet pressures to 1,400 lb. per sq.in. and superheating it to 800 deg. Thus, in many cases where a condensing bleeder turbine has to be installed, a back-pressure turbine with variable inlet pressure can be used.

Absence of drums in the Benson boiler makes it possible to arrange the boiler tubes to accommodate the general plant design and structural requirements. Tubes of 20- to 30-mm. bore are used in the construction of present-day Benson boilers. Parts forming the heating surfaces are

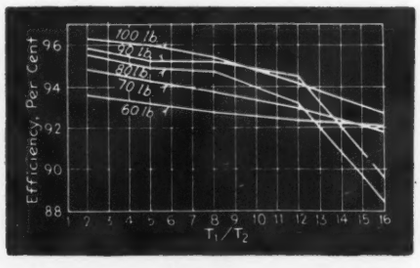
[1]Abstract of paper presented before the Institute of Electrical Engineers, London, Feb. 15, 1934.

grouped to form elements which are differently designed, according to whether they are intended for the radiation part or for the convection part of the boiler. Elements for the radiation part consist either of coiled or of straight vertical tubes with headers at the lower end and collectors at the upper end, and downcomers leading to the next element or group. Elements for the convection part consist of separate coils, one clockwise, one counter-clockwise, which together form the heating element when inserted into one another. These are provided with supports at the return bend, and are built into this boiler as a whole.

TO STUDY WORK REQUIRED TO FLEX BELTS

IT HAS long been known that the efficiency of belting is dependent on the load transmitted, says Prof. C. A. Norman, in the "Engineering Experiment Station News" of Ohio State University. Belt losses consist of slip and creep and of work due to flexing on the pulleys. The latter is constant, no matter what power the belt transmits. Hence, it is a greater percentage of a light load than of a heavy load, the efficiency decreasing as load decreases. That idling and low-load losses may be a serious burden in belt-driven machinery has been known for a long time. Many years ago Professor Benjamin discovered a case in which the idling losses of belt-driven shafting amounted to 77 per cent of the available power. A qualitative idea of how efficiency may vary with load is shown by the curves in the figure, from a series of researches not yet published.

Variation of belt efficiency with changes in tension between tight and slack sides



The efficiency shown is plotted against tension ratio. Tension ratio is a measure of tightness; the higher it is, the slacker is the belt. A tension ratio of 2 indicates that the belt is very tight. Tension ratios of 10 and more mean that the slack-side tension is only 10 per cent or less of the tight-side tension; in other words, that the belt is extremely slack.

Both for high-speed drivers and for low-load conditions it is important to study the flexing work of modern belts. This is one series of research on which the Engineering Experiment Station, Ohio State University, Columbus, Ohio, has embarked and hopes to be able to carry through as soon as financial resources permit. It is suggested that persons interested in such matters communicate with Prof. Norman or with the Engineering Experiment Station. With the joint support of several belt-makers and belt-users, the burden of carrying out this work would not be heavy. A belt may appear to be a rather simple machine element, but we do not have available, by any stretch of the imagination, the necessary knowledge properly to evaluate all factors that influence its performance.

PAINT VERSUS BUBBLES

HOW does steam form on a boiler tube? Each engineer has his own conception of this, but few know from personal observation; boilers are opaque. For that reason, readers of *Power* will be interested in the series of experiments recently conducted by The Dampney Company of America and viewed by a member of the *Power* staff.

To make steaming action visible and show the effect of painting the surface, The Dampney Company has "turned the boiler tube inside out." Heat is supplied electrically from the inside of the tube. Water on the outside is enclosed by a glass jar so that the bubble formation is visible.

Perhaps the most interesting discovery was that the condition of the tube surface has a remarkable effect on bubble formation. This is clearly evidenced in the photograph. In both jars shown the short sections of 1½-in. O.D. steel boiler tubing are heated by 300-watt, 110-volt electric cartridge-type heater elements, snugly fitting into the tubes. The tubes are closed by brass disks at the bottom.

The photo shown was taken in 1/100,000 sec. by the light of a 16,000-volt spark.

As seen in the photograph, and even more clearly evident by direct observation, bubbles arising from the paint-coated tube on the left are much smaller, more numerous and more evenly distributed. To put it in simple language, the tube at the left "boils smoothly all over," while that at the right gives off steam in gulps and from a few spots only.

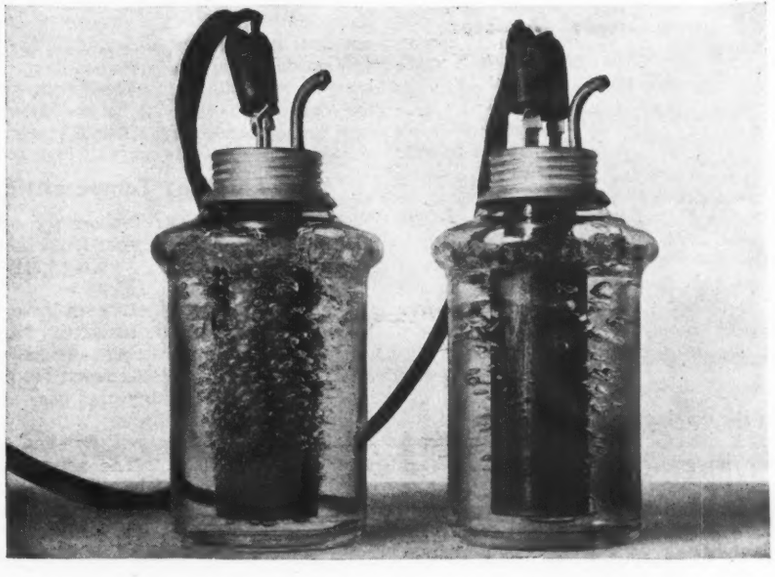
This action was made even more evident by surrounding each boiler tube with a piece of glass tube, leaving a ⅛-in. annular space.

Tests seem to indicate a slightly better heat transmission (in the neighborhood of 1½ per cent) through the coated tube, but this has not been definitely established. Paint used in the tests was Apexior Number 1.

It is not yet known just what practical conclusions may finally be drawn from the interesting effects shown by these experiments, but it would appear to open the possibility of some slight increase in boiler efficiency and capacity and also a reduction (not yet demonstrated) in priming and foaming.

The mechanism of the result is not well understood, but it seems likely that the minute surface granulations produced by the paint are a factor. Another suggestion is that improved bubbling results from increased "wetability" of the surface.

Conditions identical for two jars, except that boiler tube on the left is painted



READERS' PROBLEMS

QUESTIONS for Our Readers

Duplex Feed Pump Gives Trouble

QUESTION 1

A DUPLEX *pump is being used in our plant to return condensate to the boilers from a small reservoir to which traps return hot water. The reservoir is about 4 ft. from the pump and the water level stays 5 to 6 ft. below the pump suction. Fireman says the pump was overhauled a year ago and ran fairly well for a time. Now it runs with a jerky motion and does not put much water in the boiler, even after fresh piston packing is put on the water pistons. Perhaps the readers of* POWER *can suggest what has happened to make the pump act in this manner.*

C. A. C.

Reducing Valve Makes Noise

QUESTION 2

WE HAVE *a 4-in. reducing valve that provides steam at 5-lb. pressure from a 50-lb. main. When in use, this valve makes a singing noise that has become very objectionable. The noise seems to travel along the low-pressure pipe for a considerable distance, so carrying the noise out of the room in which the reducing valves are located. I should like to know what I can do to either stop the noise or make it less objectionable.*

Would a larger or a smaller valve cure the trouble?—A. S. H.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

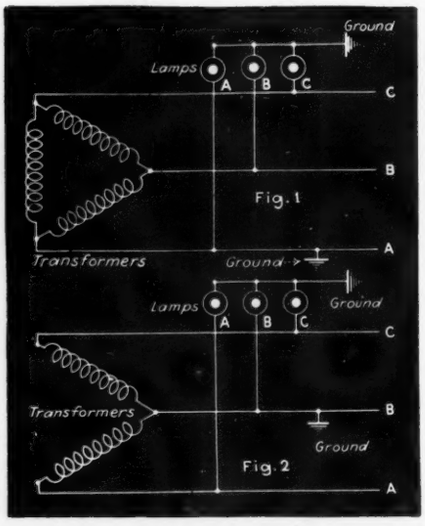
3-Lamp Ground Detector

GROUND LAMP OPERATION ON A THREE-PHASE CIRCUIT—*Fig. 1 shows the connections of a 3-lamp ground detector on a 3-phase circuit. Normally the lamp operates at part brilliancy. Why do they not operate at full candlepower? What will happen if a ground develops on one leg of the circuit? On a circuit supplied by open-delta connected transformers as in Fig. 2, one ground lamp burned at full candlepower and the other two were dark. What caused this condition? When all the lines are free of ground, should all the lamps burn dimly as on the delta-connected transformers?*

O. E. G.

On the diagram of delta-connected transformers shown, the three lamps are connected in star. Therefore, the voltage across each lamp is that between any two of the conductors divided by 1.732. That is, if the voltage between conductors is 120 volts, then the volts across each lamp is $120 \div 1.732 = 69$ volts, which accounts for the lamps burning dimly.

Under similar conditions, the lamps should operate the same on a 3-phase circuit supplied by transformers connected open-delta as they do on a 3-phase circuit supplied by transformers connected closed-delta. The conditions you report obtaining with the open-delta transformers can occur, but not under normal operating conditions. For example, assume that lamp C is burned out, or in some way the circuit is not complete for it, and that there is a ground on line B. Then both terminals of lamp B will be connected to ground, and will therefore be at the same potential and will not light. The circuit for lamp C we have assumed to be open, and therefore that lamp is out. The circuit for lamp A is from line A through lamp A to ground, and back through the ground to line B, therefore this lamp will burn at full brilliancy, if designed for line voltage.



Normally, as explained for the delta-connected transformers, when the system is insulated the three lamps should burn at reduced brilliancy. If a ground occurs on one line, such as line A in Fig. 1, lamp A will go dark and the other two lamps will burn at full brilliancy. The line to which the dark lamp connects is the grounded line, as you can see from the diagram.

High Flue-Gas Temperature

WHAT ARE CAUSES—*What are the causes of excessively high flue-gas temperature?*—S. C.

High flue-gas temperature may be due to soot outside or scale inside the heating surface, insufficient heating surface, and leaky baffles. It may also result from too much excess air, forcing the fire, afterburning of the flue gas.

Correct measurement of flue-gas temperature is not easy. The thermometer or thermocouple should be shielded so that it will not radiate to the colder surface of the boiler. Failure to do this will result in a temperature reading that is too low.

Synchronous Condenser

WANTS TO KNOW WHEN TO USE SYNCHRONOUS CONDENSER—*At our plant we have a non-condensing turbine-driven alternator with a name-plate rating of 240 volts, 900 amp. max., 3-phase, 60 cycle, 3,600 r.p.m., 300 kw. at 0.80 power factor, that supplies the night load. There is also a 220-kw. 240-volt synchronous condenser in the plant and the generator voltage is controlled automatically. Before starting the condenser one night, the meter readings were: Alternating-current voltage 240, amp. 500, exciter voltage 105, field amp. 31.5, power factor 0.62. The condenser was started and when the load became constant the meter readings were: Alternating-current voltage 240, amp. 380, exciter voltage 80, field amp. 23, power factor 100, condenser amp. 350 and condenser field current 28 amp. Is plant economy improved by operating the synchronous condenser?*

H. M. T.

Since the condenser is in the power plant there is nothing to be gained by operating it as long as the generator can supply the load and maintain voltage. Assuming the kilowatt load supplied to the feeders to be the same under the two operating conditions given in the question and each machine equipped with a direct-connected exciter, the alternating-current load in kilowatts for a 3-phase circuit is:

$$Kw. = \frac{E \times I \times P.F. \times 1.732}{1{,}000}$$ or in this case is,

$$Kw. = \frac{240 \times 500 \times 0.62 \times 1.732}{1{,}000} = 129$$

The exciter load is $Kw. = 105 \times 31.5 = 3.3$. Then the total load on the turbine is $129 + 3.3 = 132.3$ kw., plus generator losses.

With the condenser in operation, the alternating-current load is:

$$Kw. = \frac{240 \times 380 \times 1.00 \times 1.732}{1{,}000} = 158$$

The exciter load is kw. $= 80 \times 23 = 1.8$ and the total load on the turbine is $158 + 1.8 = 159.8$ kw., plus generator losses. This gives a difference of $159.8 - 132.3 = 27.5$ kw. in favor of operating without the condenser. The combined losses of generator and condenser will be greater than those of the generator alone. This will increase the differential in favor of operating the generator alone when it can supply the load and maintain voltage.

Pitting of Heating Boiler

CORROSION AND PITTING OF BOILER AND TUBES—*Our heating system is a Warren Webster vacuum system, using a Nash electric-driven vacuum pump and receiver for returning condensate to the boiler. The return is higher than the steam main, and lift fittings are used to elevate the con-*

densate from the steam mains. As I see it, dissolved oxygen is brought into the condensate by the high vacuum required to lift the condensate. This, returning to the boiler untreated, causes corrosion and pitting of boiler and tubes. Can you advise of any treatment that will stop pitting of this kind and what method of testing the water may be used to determine if the condition is active or not. Is there any treatise on this subject; who is the author and where may it be had?—L. T. K.

(The following reply was prepared by W. J. Ryan, Water Service Laboratories, Inc., New York City—Editor)

The pitting is probably due to oxygen introduced in solution in the make-up water and oxygen in the condensate caused by air leakage into the heating system. The corrosive action of the oxygen may be accelerated by the presence of CO_2, which will also be present in solution in the make-up water. CO_2 is also generated in the boiler by the breaking down of bicarbonate salts in the feed water, or by salts found in some boiler compounds.

The first thing to do is to make all joints in the heating system as tight as possible, and reduce the amount of make-up to a minimum by making sure there is not a leaky blow-off or some other source of waste of water or steam. It would also be advisable to keep the water in the boiler alkaline with caustic soda to the extent of about 100 ppm. hydroxide alkalinity.

Further steps would be the installation of a deaerating heater, or the use of a chemical treatment based on adding sodium sulphite to the returns in the required amount, which will depend on the amount of oxygen in the condensate.

Detailed instructions for testing for dissoved oxygen can be found in "Standard Methods of Examination of Water and Sewage," published by the American Public Health Association, 450 Seventh Ave., New York, N. Y. Such a test requires some skill to be made properly and therefore should be performed by a competent industrial water chemist, who can also advise on proper treatment of the water.

One of the most comprehensive discussion of corrosion in heating systems and boilers is contained in "Corrosion; Causes and Prevention," by F. N. Speller, published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y.

Increasing Plant Capacity

ANSWERS to February Question 1

THE QUESTION

WE HAVE *a 7,000-kw. turbine arrangea to bleed steam at two points for heating feedwater to 325 deg. F. Our fuel-burning equipment, however, has only sufficient capacity to produce enough steam for generating 6,500 kw.—a few hundred additional kilowatts of load causes steam pressure to drop. Will we be able to carry more load on our turbine-generator if we decrease the steam bled to the high-temperature feedwater heater, thus allowing more steam to flow through the turbine to the condenser but decreasing the final feedwater temperature? Piping conditions prevent our trying this, and before making the changes necessary we would like the opinion of* POWER *readers.*—J. A. D.

Coal per Kw.hr. Reduced By Bleeder Heating

THE MAIN OBJECT in using steam bled from a turbine for feed-water heating is to reduce the amount of heat that the boiler must supply per kilowatt-hour generated. Bleeder operation makes use of the latent heat of the steam extracted for feed-water heating, after partial expansion, which would be lost if allowed to expand to the condenser.

With strictly condensing operation, the heat supplied per kilowatt-hour generated is greater due to more heat lost to the condenser.

If an attempt is made to reduce the amount of steam bled it would mean an approach toward strictly condensing operation. With this condition the boiler plant would be called upon to furnish a greater amount of heat per kilowatt-hour.

The ability of a boiler plant to produce heat, in the form of steam, is based upon its fuel-burning equipment. Since the output of this equipment is limited, a change toward complete condensing operation would mean a decrease in the output of the turbine rather than an increase.

Baton Rouge, La. G. F. MATTHES.

Emergency Overload By Decreasing Bled Steam

THE PRACTICE of cutting out high-pressure extraction heaters is sometimes resorted to to carry emergency overloads on turbines only, however, when ample boiler or hot-water storage capacity is available. This practice while reducing steam flow at the turbine throttle, increases the station heat rate, thus adding an additional burden to the fuel-burning equipment. If the boiler is equipped with an economizer, boiler efficiency will be somewhat increased by lowering the feed-water temperature. This, however, will not offset the increased heat rate of the plant due to increased condenser loss.

Installation of air preheaters would no doubt increase the efficiency and capacity of the fuel-burning equipment sufficiently to carry the load. With feed-water temperature of 325 deg. the addition of an air preheater would be practical, even though the boiler were equipped with an economizer. RAYMOND SEPTOR.

South Amboy, N. J.

Increase Fuel-Burning Capacity

DECREASING the amount of steam bled to the high-pressure feed-water heater, thus decreasing the final feed-water temperature, will result in further loss of capacity.

Best station efficiency is obtained with maximum extraction of steam from the turbine for feed-water heating, other things being equal. If the amount of bled steam is reduced as proposed ,the load carried by the turbine will be momentarily increased, because of the larger amount of steam passing through the latter stages of the turbine. However, the steaming capacity of the boilers will be decreased on account of the lower feed-water temperature. This will more than off-set the increased load carried by the turbine, and the net result will be a loss in capacity of the station.

It is possible that the desired increase in load may be obtained by some small change which will increase the efficiency of the station, or it may be necessary to increase the capacity of the fuel-burning equipment.

Zanesville, Ohio. WESTON A. BROWN.

Plant Capacity Decreased

THE QUESTION states that the fuel-burning equipment rather than the turbine is loaded to capacity. The turbine itself still has at least 500 kw. reserve capacity with the fuel-burning equipment loaded.

Stage heating of boiler feedwater is used in a steam plant to increase the over-all thermal efficiency of the plant. Otherwise there would be no reason for the costly installation of this equipment. If the effect of these feedwater heaters is counteracted by cutting off the steam from them, the over-all efficiency of the station will be lowered. This will call for more B.t.u. per kw.-hr. generated, in turn calling for more steam, and likewise more fire, rather than less. However, as it was stated that the fuel-burning system was already loaded to capacity, this will be just the opposite of the effect desired, and the capacity of the station will be lowered rather than increased.

As a more concrete explanation, let us consider the steam after it has passed through part of the turbine blading and has reached a heater extraction line. If this steam is allowed to expand through the remainder of the blades, the most that can be realized from it is its present heat content minus the enormous condenser loss (due to condensation) times the efficiency of the turbine. This condenser loss is naturally very high, amounting to 900 to 1,000 B.t.u. per lb. in the average installation. However, if this steam is extracted and used to heat the feedwater, practically all of the heat normally lost in the condenser is reclaimed in the heaters, as the heat of condensation constitutes the major portion of the heat given to the feedwater by the extraction steam. To eliminate this extraction steam and send the steam on through the turbine would naturally be ridiculous, unless, possibly, a little more capacity from the turbine itself were required.

The author of this question should look not to his feedwater heaters, but, rather, to his fuel-burning equipment for additional capacity. R. F. SORRELLS.

Beaumont, Texas.

Capacity Increased By Decrease in Steam Bled

THE APPROXIMATE water rates of a 7,000-kw. turbine with various degrees of extraction are: (Initial pressure 200 lb.,

bleeder pressure 5 lb., vacuum 1 in. Hg., superheat 150 deg.)

Extraction, %	0	10	20	30	40	50
Water Rate, lb./kw.-hr.	12.0	12.5	13.2	14.2	15.3	16.5

For the fuel equipment to maintain a load of 7,000 kw. as against the present maximum of 6,500 kw., the steam consumption of the machine must be reduced 7 per cent. Whether this can be done depends on the amount now extracted, which cannot be calculated because of insufficient data supplied. The problem can only be analyzed in the light of several assumed conditions.

If the steam extracted is used to heat the condensate only, and it is heated from 212 to 325 deg., then the amount bled is about 10 per cent. (Under this assumption the condensate is first heated in an open heater with exhaust steam from other sources.) If this is the case, solution of the problem in the manner suggested is not feasible, because even if bleeding were altogether dispensed with, the water rate would not be reduced sufficiently to permit the boilers to carry a load of 7,000 kw. However, a load of 6,700 kw. is possible.

If the condensate is being heated from the hot-well temperature to 325 deg., the extraction must be about 20 per cent. By doing away with bleeding, 7,000-kw. load can be maintained, but there will be no steam available to heat the condensate during peak load.

If the steam is used to heat other water besides the condensate, the amount extracted is probably over 20 per cent, but if it is less than 30 per cent there will not be sufficient steam during peak load to heat the feed water to the minimum of 212 which is required in good practice.

Only if the extraction is over 30 per cent will it be possible to obtain the needed extra capacity by diminishing the bleeding and at the same time have enough steam to heat the condensate to 212 deg.

Of the four assumed cases, only the fourth offers a solution, but all things considered and in the absence of more exact information, it will probably be more expedient to increase the capacity of the fuel equipment in some way than to make any changes in bleeding arrangement.

Chicago, Ill. N. T. Pef.

Don't Use Generator Frame as Jack to Lift Rotor

ANSWERS to February Question 2

THE QUESTION

THE END BEARING *of an engine-driven generator was removed by lifting the field frame on its raising screws so that the shaft freed the bearing for removal. A 10-ton flywheel was on the shaft near the armature. Thus the field had to support this weight in addition to that of the armature and shaft, the crank end being lifted by a jack. The question was raised whether this was good practice, whether it should be generally used in making repairs and erecting. I would appreciate hearing from some readers of* POWER *regarding the advisability of lifting the armature in this way and the possibility of damage to the armature and polepieces. If we did not do the job properly, how should it have been done? Do the electrical machinery manufacturers recommend this practice?*—F. H.

Using Stator as Jack Is Like Riding an Alligator

TAKING OUT a bearing by using the stator as a jack is like riding an alligator—it can be done, but it isn't a good idea. The best way for F. H. to do the job is to rig a shear leg with a tackle at each end of the shaft, or use jacks and cribbing to lift the rotor, raising the stator on its jackscrews to keep the rotor in the clear at all times. If the shaft shows a tendency to roll off the jacks, use a lifting beam and two jacks. The lifting beam is placed under the shaft and blocks nailed on to prevent rolling, or the blocks may be placed over the shaft and tied to it with cable. Of course the jacks must be brought up together.

Raising the shaft with the stator jackscrews puts a heavy crushing force on the laminations that come in contact with the pole faces, a force they are not designed to stand. It is also likely to spring the stator yoke (giving an uneven air gap when the machine is reassembled), or crush the slot insulation. If clearances are such that the stator must be used as a jack, get a piece of heavy sheet steel, bend it to fit the arc of the air gap, and slip it between rotor and stator. This will distribute crushing force on the laminations.

The writer's experience embraces only one of the large manufacturers, who warns against the use of engine-driven alternator frames as jacks.

Greensboro, N. C. J. D. McConnell

Field Frame Should Not Be Used as a Jack

IF THE WEIGHT of armature, shaft and flywheel are comparatively small, as for a high-speed unit, the shaft might be lifted from its end bearing by raising the field frame on its raising screws without danger to the frame. When the rotating parts are heavy, this procedure should be avoided.

When the field frame is raised until the pole faces lift the armature, the weight of the rotating element will be concentrated upon small contact surfaces. Since the armature diameter is slightly less than that of the pole-face bore, at best, contact between the two will be along one or two narrow lines parallel to the shaft. Because of slight irregularities in the armature laminated core, it is probable that first contact will be at a few points along the expected lines of contact.

Under such loads, the armature core laminations may become permanently displaced. This displacement may be in a direction and of a magnitude sufficient to damage insulation on coils in the slots. It would be far better practice, and but little more trouble, to use screw or hydraulic jacks or the crane hoist if one of suitable lifting capacity is available than to try lifting with the field frame.

Oklahoma City, Okla. J. H. Bender

Recommends Lifting the Shaft With Jacks

A CAREFUL READING of the question leads me to assume that the end bearing is mounted on a sole plate. In this case, all that is necessary is to raise the end of the shaft sufficiently to clear the bearing. The way F. H. did the work, there was danger of breaking the field frame, or of breaking off the pads holding the lifting screws.

I would suggest that where similar repairs are to be made and a crane is not available, that a piece of 8x10-in. timber 8 or 9 ft. long be used. Cut a notch about 1 in. deep, the radius of the shaft, near the center of the timber and place it under the shaft close up to the armature. Support one end of the timber on blocking and the other on top of a jack screw. The blocking should be sufficiently higher than the jack so that when the shaft is lifted the timber will be level.

Remove bolts from the joint of field frame and the cap from the main bearing. Uncouple the eccentric rods at rocker arms, remove the wrist pin from the crosshead and push crosshead and piston rod clear of the connecting rod. It may be advisible to insert pieces of heavy canvas or similar material between polepieces and armature to prevent abrasions. Open the connections between field-coil windings at the center joint of field frame. If eccentric is tight up against main bearing, mark its position and slack off the setscrews.

Now put pressure on the jack screw to see if everything is in order. Lift the shaft high enough to obtain clearance and pull the end bearing off sole plate. If the end bearing has to be lifted over the foundation bolts, it will be necessary to raise the shaft higher than in the first case. Two timbers will be required, one next to the end bearing and one at the main bearing. An overhead chain fall may be used to steady the upper half of field frame, which can be lifted with the armature by the jack screws.

Troy, N. Y John F. Nagle

Design of Machine Determines How It Should be Handled

LIFTING armature and shaft, including the flywheel, with the field-frame adjusting screws is not good practice. Much depends on the design of the machines. Small machines may be lifted bodily by either element without damage. The fact that F. H. lifted the armature with the field frame without apparent injury to either part does not necessarily prove that it is good practice.

Large slow-speed machines are not designed to withstand such strains and may be seriously damaged by such treatment. The armature and flywheel should be lifted separately by the most convenient or suitable means available, such as by hoist or screw jacks.

Birmingham, Ala. A. F. Elliott

THE ENGINEER'S BOOKSHELF

Recovery Program

THE ECONOMICS OF THE RECOVERY PROGRAM (1934). *By Seven Harvard Economists. Published by Whittlesey House, 330 West 42nd St., New York, N. Y. 188 pages, 5x8 in. Clothboard covers. Price $1.50.*

Seven members of Harvard's Economics faculty express their individual opinions of various aspects of the New Deal. Here is the coverage: Schumpeter, Depressions; Chamberlin, Purchasing Power; Mason, Controlling Industry; Brown, Helping Labor; Harris, High Prices; Leontief, Helping the Farmer; Taylor, Economics Versus Politics.

It is evident that the scholarly authors of this book have made a real effort to view events objectively. They stress the fact that they have no political axes to grind. In the face of this it is quite clear that they are not sold on many aspects of the Recovery Program. They pick out, or seem to pick out, many fallacies in popular thinking on prices, hours of labor, farm aid, etc. They seem to be honestly in sympathy with the social aims of the New Deal, but to question whether the machinery used and the rules for its operation are properly directed to the desired end.

Realists of all political persuasions should enjoy reading the last chapter, "Economics Versus Politics." Here is something that no orthodox economist of thirty years ago would have written. It is a clear recognition that non-economic factors play almost a major part in economic results. Economists, nowadays seem to be paying more attention to "politics." As they do so, they will become better guessers. All of which makes one wonder whether, even now, there may not be a lot more guesswork in economics than some of its professors will admit.

Patents

INVENTIONS, PATENTS AND TRADE-MARKS —THEIR PROTECTION AND PROMOTION *(A revision and enlargement of "Inventions and Patents"). By Milton Wright, Attorney and Counsellor at Law. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y.; 310 pages, 5½x8 in. Cloth. Price, $2.50.*

This is a practical manual on how to choose a patent attorney, what patent office procedure is, what traps are set for patentees, how to estimate the value of a patent, how to determine the best method of disposing of a patent, etc. This second edition is designed for the manufacturer and merchant, as well as the patentee. It therefore includes information on trademarks and copyrights, print and labels, designs, royalties, selling patented articles, advertising and publicity, foreign patents, infringement, damages and accounting, and one hundred questions and answers on protection of patents. This is particularly important to business men now, because it shows the extent of protection these devices give. Their value in competition under the New Deal becomes more a matter of originality of the product, its distinctive features, etc.

High-Speed Diesel

THE MODERN DIESEL (HIGH-SPEED COMPRESSION-IGNITION ENGINES) (SECOND EDITION)—*Published by Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S. E. 1, England. 184 pages, 5x7¼ in. Clothboard covers. Indexed and well illustrated. Price 3 shillings, 6 net.*

This concise but comprehensive treatise was prepared by the editors of the publishers' group of technical papers, and is planned for use as a handbook of British and European high-speed compression-ignition engines. Historical and engineering design material are included, as well as views of various types of fuel pumps, nozzles, combustion chambers, auxiliary air chambers, governors, transport engines, aircraft engines, and marine engines. Service and cost data are given, tables of characteristics, and other pertinent data on this type of engine which is rapidly increasing in importance. The work is up to date and complete.

Thermodynamics

ELEMENTARY ENGINEERING THERMODYNAMICS (1933)—*By Theodore H. Taft, Associate professor of heat engineering, Massachusetts Institute of Technology. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 229 pages, 5¾x8¾ in. Clothboard covers. Indexed and 144 illustrations. Price $2.75.*

This is primarily a text for brief study of thermodynamic principles and more common engineering applications. Consequently, language is simple and many of the proofs necessary for complete theoretical discussion are omitted. Its content may possibly be best described by a list of chapter headings: Introductory Definitions —The First Law and Its Factors, The Availability of Energy and the Second Law, Entropy and Irreversibility, General Heat Changes and Steady Flow, Perfect Gases, Vapors, Flow of Fluids, Elementary Steam Turbine Theory, Theoretical Vapor Cycles, The Reciprocating Steam Engine, Steam Boilers, Fuels and Combustion, Compressed Air, Theoretical Gas Cycles, Refrigeration, Mixtures of Air and Water Vapor. This text should prove of value to equipment designers and to the power engineer interested in studying the theoretical aspects of his job.

BRIEF REVIEWS

MECHANICAL POWER TRANSMISSION. *Mechanical Power Engineering Associates, 684 St. Marks Ave., Brooklyn, N. Y.*—Well illustrated booklet discussing and summarizing uses of modern group drives.

EFFECT OF OVEN HUMIDITY ON ACCELERATED WEATHERING TESTS OF COAL. *By E. Stansfield and K. C. Gilbart. Technical Bulletin No. 543. of the American Institute of Mining & Metallurgical Engineers, New York, N. Y.*

BRIQUETTING ILLINOIS COALS WITHOUT A BINDER BY COMPRESSION AND BY IMPACT, A PROGRESS REPORT OF A LABORATORY INVESTIGATION. *Prepared by Illionis State Geological Survey, Urbana, Ill. Price $0.25.*—Results of experimental work of preparing coal briquets.

PROGRESS IN THE REMOVAL OF SULPHUR COMPOUNDS FROM WASTE GASES. *By Henry Fraser Johnstone. Reprint No. 2 of Engineering Experiment Station, University of Illinois, Urbana, Ill. Price $0.20.*—Results of experiments indicating the remoteness of economically washing large quantities of gases with untreated water. Report on other work which is under way.

RELATIVE EFFICIENCIES OF DOMESTIC FUELS IN RELATION TO THEIR COSTS AND THEIR ADVANTAGES. *By Ralph A. Sherman, Fuel Engineer, Battelle Memorial Institute. Issued by American Institute of Mining & Metallurgical Engineers.*—Analysis of total costs of domestic heating by various fuels and types of equipment.

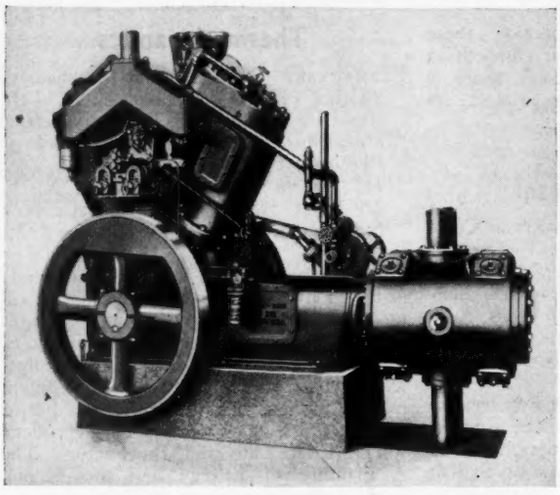
EMBRITTLEMENT IN BOILERS. *By Frederick G. Straub. Second edition of Bulletin No. 216 of Engineering Experiment Station, University of Illinois, Urbana, Ill. Price $0.85.*—Results of an investigation begun eight years ago relative to cracking in boiler plates known as "embrittlement cracking," to determine the cause of the difficulty and methods of preventing it.

CLASSIFICATION OF COALS OF THE UNITED STATES ACCORDING TO FIXED CARBON AND B.T.U. *By W. A. Selvig, W. H. Ode and A. C. Fieldner. Technical Publication No. 527 of the American Institute of Mining & Metallurgical Engineers.*

WORLD POWER CONFERENCE. *Transactions of the Scandinavian Sectional Meeting, 7 vol. Price $40, F.O.B. New York. Transactions of the First Congress of the International Commission on Large Dams, 5 vol. Price $18, F.O.B. New York.*—American Committee, World Power Conference, Chrysler Bldg., New York, N. Y.

1933 A.S.T.M. PROCEEDINGS. *Part I, Annual Reports, Committees, new and revised standards; Part II, Technical papers. Published by the American Society for Testing Materials, Philadelphia, Pa. 1,900 pages. Price, per part—paper $5.50, cloth $6, half-leather $7.*—Part I, with 1,092 pages, contains the annual reports of 40 standing committees and research and sectional committees, together with 47 new and 37 revised specifications and tentative standards. Part II, 804 pages, contains all papers at the 1933 annual meeting.

WHAT'S NEW IN PLANT EQUIPMENT



Air and Gas Compressors

Units consist of vertical, 4-cycle, multi-cylinder, V-type gas engines with direct-connected, horizontal, compressor cylinders. Moderate weight permits shipment assembled and minimum foundation. "XVG" units in four sizes of 60, 125, 190 and 260 hp. with 2, 4, 6 and 8 power cylinders respectively, two power cylinders per compressor cylinder. Bulletin.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

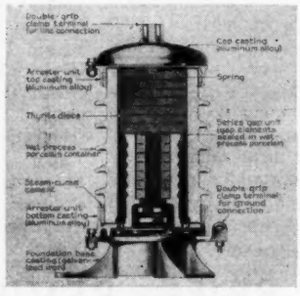
Iris Shutter Valve

Hand or power operation, piston or motor driven, and can be set for a position orifice to give measured flow of gas or air. One valve can be set on air, another on gas, to obtain proper mixture. Sizes from 1-in. to 72-in.

York-Lalor Division, York Oil Burner Co., Inc., York, Pa.

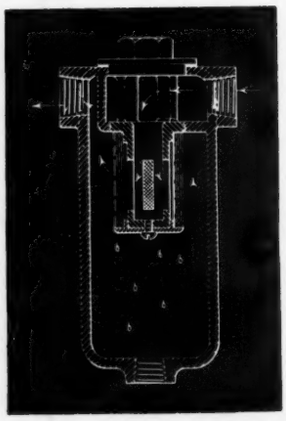
Station-Type Lightning Arresters

Form D Thyrite station-type lightning arresters offer improved protection and mechanical construction, including no-time lag. Impulse breakdown voltage of 11.5-kv. unit is about 40-kv. crest. Applying A.I.E.E. standard surge current (1,500 amp.), impulse voltage across arrester unit is limited to only 36-kv. crest, an improvement of 30 per cent over previous designs. Sealed construction of series gap protects gap elements from moisture or atmospheric influences. Standard 11.5-kv. arrester units interchangeable in arresters of all voltage ratings. Series gap hermetically sealed,


Double-grip clamp terminal for line connection
Cap casting (aluminum alloy)
Arrester unit top casting (aluminum alloy)
Spring
Thyrite discs
Series gap unit (gap elements sealed in wet-process porcelain)
Wet-process porcelain container
Steam-outlet connection
Double-grip clamp terminal for ground connection
Arrester unit bottom casting (aluminum alloy)
Foundation base casting (gasket seat shown)

metal caps being bottle-cap-crimped over ends of porcelain container, with gaskets permanently locked in position.

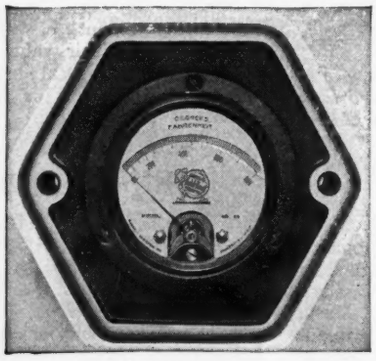
General Electric Co., Schenectady, N. Y.



Steam Separator

Intended for application on individual steam lines serving heat-transfer and process equipment. Modification of Gast compressed air separator, zig-zagging moisture-laden vapor through several layers of coarse mesh screen. Screen readily removed for cleaning. Sizes ½ to 2-in.

Johnson Corp., Three Rivers, Mich.



Pyrometer

"Hold-Heet" pyrometer designed for incorporation in engines, etc. Two ranges, 60-800 deg. F., 60-1,600 deg. F. Hexagonal aluminum case 5⅜ in., with leads from top, bottom or either side to No. 6 gage thermocouple. Also special connections, different ranges, larger meters, etc. Manual cold-end adjustment. Direct-reading unit with total resistance of only 10 ohms; maximum possible error due to external resistance less than 1 in 150 parts. Bulletin.

Russell Electric Co., 363 West Huron St., Chicago, Ill.

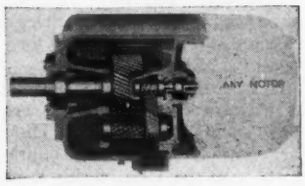
Gasket-Type Drop-Forged Pipe Coupling

Champion positive-seal pipe coupling makes possible joining of straight plain-end pipe without grooving, threading, beveling or upsetting its ends, no extra finishing operation being necessary. Tension tests show tensional strength greater than that of threaded joint. Gasket seal has been tested up to 4,000 lb. per sq.in. successfully. Gasket provides double seal effective against either pressure or vacuum. Two steel reinforcements prevent pinching of gasket by coupling halves during assembly.

Champion Machine & Forging Co., Cleveland, Ohio.

Motorized Speed Reducer

Series HD "Rite-Lo-Speed" motor combines helical gear

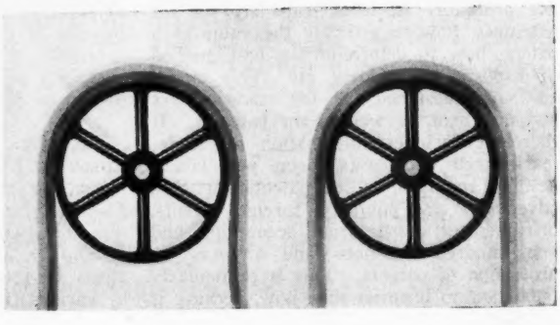


transmission and motor of any make or characteristics to deliver power at required speed. Transmission housing is in two major parts, dowelled and machined together. Radial ribs reinforced by heavy base maintain rigid alignment. Furnished with or without extended high-speed motor shaft, and can be mounted horizontally on floor, wall or ceiling. Vertical units are footless and provided with oil pump and sprays, base ring and canopy. Principal dimensions conform to NEMA standards for motors. Original Christian design under Patent No. 1,860,703, issued to J. D. Christian. Bulletin. Patent now owned by:

Falk Corp., Milwaukee, Wis.

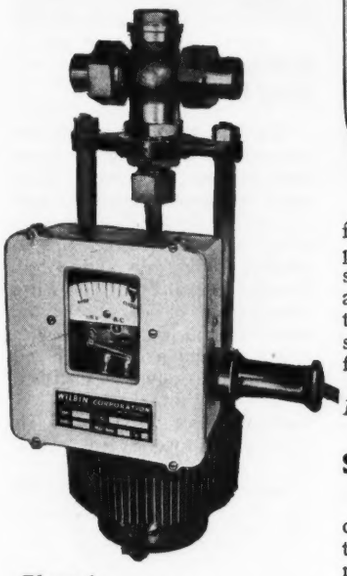
Power-Transmission Belting

Designed for modern small-pulley drives. Claimed to increase adhesion to compensate for small area of contact, to reduce stretch and to reduce internal friction. Vegetable-tanned leather with high adhesion, thoroughly stretched. In single-ply belts, leather with minimum stretch is used; in double-ply, outer ply is more elastic leather. In belt at left



in illustration, plies have same stretch, thus inner ply tends to wrinkle and lessons adhesion; in belt at right, outer ply has greater stretch, thus insures smooth belt fit on pulley. Called "Monobelt," and can be used anywhere except where belt is subject to reverse flexing. Waterproof. Only one standard thickness for each width. Claimed higher efficiency and higher hp. Bulletin A-109.

Alexander Bros., 406 N. Third St., Philadelphia, Pa.



Electric Temperature Control

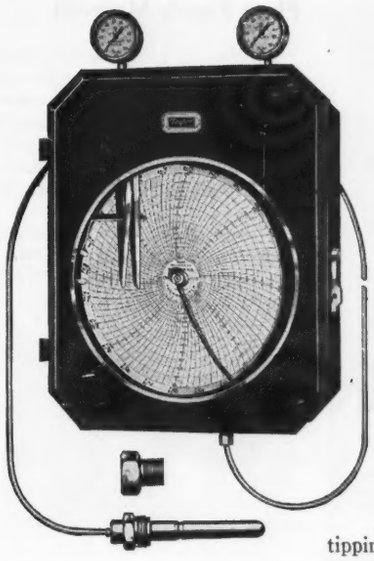
Automatic valves for steam, gas, oil, water or brine flow control, actuated by thermostats of various kinds, are fitted with a "heat motor" to operate valves. Illustrated is Wilbin heat motor valve Type C, for throttling control of temperatures from minus 40 deg. F. to 650 deg. F. Motor consists of pressure chamber in which a volatile fluid is vaporized by an electric strip heater. Pressure compresses flexible bellows in the chamber. Valve plunger is attached to this bellows and moves upward when the bellows is compressed. Limit switches, actuated by valve stem itself, control and reverse valve stroke. A device for interrupting electric circuit makes it possible to arrest valve travel at any point between open and closed positions. Combinations suitable for process industries, refrigeration, air-conditioning, etc.

Wilbin Instrument Corp., 40 East 34th St., New York, N. Y.

Recording Regulators

Regulators for temperature, pressure, flow, or liquid level have sliding adjustment for balanced control. Regulator action can be quickly chanced from direct to reverse. Compensating device maintains desired control under fluctuating air pressure. Easily converted to either temperature or pressure instrument. Face- or flush-mounted.

Taylor Instrument Co's., Rochester, N. Y.



Supersensitive Relay

Model 705 relay will make contact on values down to three micro-amperes or one millivolt and contacts are capable of handling five watts at 110 volts, non-inductive load. Used with photo-electric cell for industrial control and with thermo-couples for temperature control.

Weston Electrical Instrument Corp., Newark, N. J.

Globe and Angle Valves

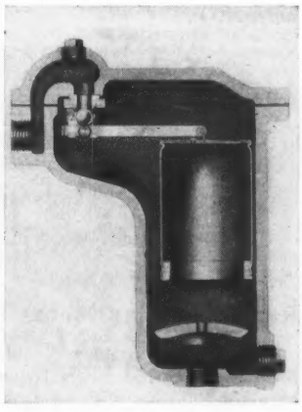
Feature is cadmium plating of malleable-iron union bonnet ring and stuffing box nut, for permanent protection against rusting and self-lubrication on threads. Bronze-to-bronze true union joint between body and bonnet. Stem head has rounded machined bottom surface which makes a low-friction bearing contact with a smooth milled recess in disk holder. Four guide prongs on disk holder prevent tipping or binding as valve is opened or closed. Can be repacked under pressure. Sizes from ¼ in. to 3 in., suitable for 150-lb. working steam pressure and 250-lb. working water pressure.

Kennedy Valve Mfg. Co., Elmira, N. Y.

Inverted-Bucket Steam Trap

Operates on inverted-bucket principle. Water passes freely through trap without raising bucket. Steam will cause bucket to become buoyant, rising and closing valve. Air is vented through hole in top of bucket and discharged as valve opens on next cycle. Free-turning ball valve gives long service and correct seating. Curved baffle over inlet prevents pulsating pressures from interfering with operation. Valve and seat, lever and all pins are stainless steel.

D.G.C. Trap & Valve Co., 9 E. 46th St., New York, N. Y.



Light Source for Phototube Controllers

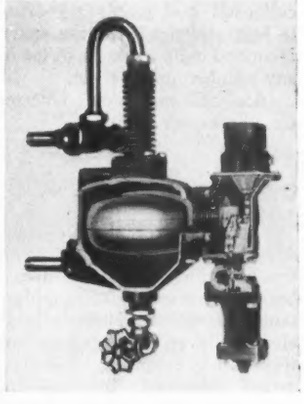
Particularly useful where light beam is transmitted over a considerable distance or where it must penetrate steam, dust or similar semi-translucent substances. An intensity of 24 foot candles is obtained at 25 ft. Type E light source consists of an industrial lamp rated at 6 volts, 5 amp. and 3,000 hours life and a lens for condensing light rays into a nearly parallel beam. Adjustment can be made of lens focus to locate beam without removing cover.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Steam Trap

"Detroit" steam traps, including return, vacuum, combination, and separating traps and "Detroit" receiver now handled by company below. This trap is an arrangement of valves, actuated by tilting tank through an arrangement of levers. Tank, mounted eccentrically, on hollow trunnion, is held in horizontal position when empty by means of large counterweight. When tank fills with water (through hollow trunnion) counterweight is over-balanced and tank tilts, actuating valves. Does not require lubrication. Able to handle water and return it to boiler at temperatures as high as 335 deg. F. Counter records number of operations allowing check on feed-water, heater capacity, etc.

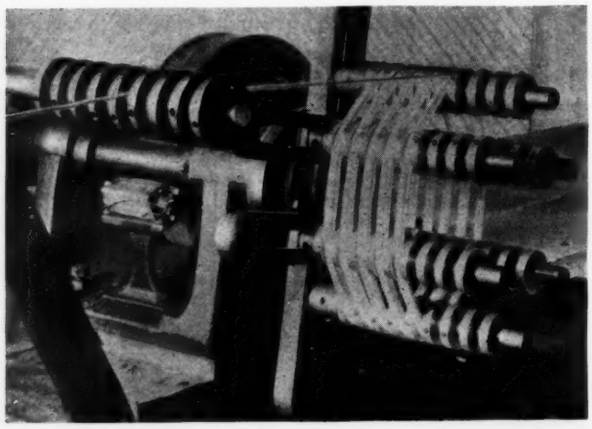
Nason Mfg. Co., 71 Fulton St., New York, N. Y.



Boiler Water Level Control

Automatic boiler water-level control illustrated is Safety Feeder No. 37, for boilers to 2,500 sq.ft. Other sizes for larger units, any firing method. Quickly connected. Feed-valve and other working parts isolated from float chamber, avoiding scale collection. Valve hardened stainless steel. No. 35 low-water cut-off switch is also shown. If excessive priming or foaming causes water to leave boiler faster than feeder can supply it, switch stops burner or stoker until feeder catches up.

McDonnell & Miller, Wrigley Bldg., Chicago, Ill.



Coil Winder

"Ideal" coil winder can be used for making motor, armature, field, transformer and other types of coils with diamond, round, square or rectangular cores. This unit is light and quickly adjustable, and adaptable to almost any shape and size. No wearing parts, and form tubes may be removed instantly from finished coils. Face plate is of welded steel, which can be fitted to any lathe head easily. Set-up from one type of coil to any other type can be made in a few minutes. Since no solid side walls are used, each layer of field or transformer coils can be laced with tape, so when machine is collapsed coil needs no tying to keep it from springing apart. Diamond coils made in series of any number up to eight.

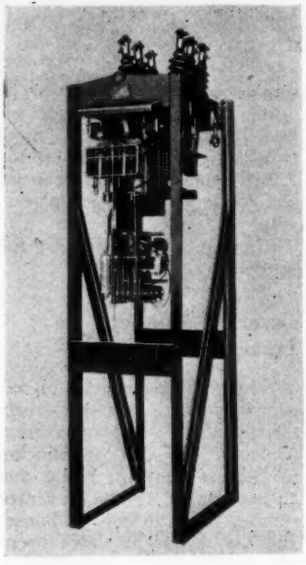
Ideal Commutator Dresser Co., Sycamore, Ill.

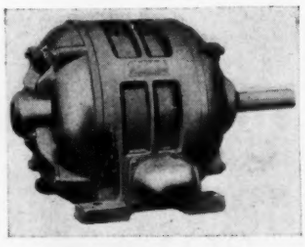
Oil-Blast Breakers

Type FKO-127 line of outdoor, oil-blast, trip-free circuit breakers for station and distribution service. Rectangular-tank type, operated manually or electrically. Either pole or framework mounting. Oil-blast action obtained by use of horizontal baffle which divides tank into a lower chamber, where arcs are drawn, and an upper chamber, into which oil and gases are discharged. As contacts part, arcs are drawn which build up sufficient pressure in lower chamber to cause a blast of oil across arc path to upper chamber, oil displacing arc products at a current zero introducing sufficient insulation to prevent arc from re-establishing. Illustration shows unit without tank or cover.

Automatic reclosing equipment can be furnished as self-contained unit, shipped assembled. Breakers rated 400 and 600 amp., at 7,500 volts, and have interrupting rating of 50,000 kva. Ratings in accordance with N.E.M.A. standards recently adopted.

General Electric Co., Schenectady, N. Y.





Rapid-Reversing Motor

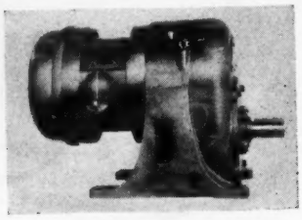
Squirrel-cage motor, capable of as many as 100 reversals per min. continuously without overheating. Light-weight rotor construction, efficient ventilation, high-torque characteristics, and shock-resisting cast-iron frame make this possible. In standard open ball bearing type or rolled-shell shaftless type and in vertical single-speed, multi-speed, enclosed fan-cooled, and other squirrel-cage types. No auxiliary ventilation needed in sizes up to 5 hp. Full line. Bulletin.

Louis Allis Co., Milwaukee, Wis.

Floor Repair Material

Amolastic, cold mastic compound, permits concrete mix for floor resurfacing to be made hard enough to stand heavy steel wheels. Amount of aggregate mixed in determines hardness. Will bond to all types of floors.

Floor Treatment Division, American Oil & Disinfectant Co., 129 East 26th St., New York, N. Y.



Gearmotor

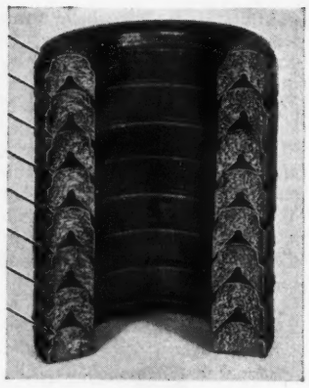
Type S single-reduction unit has been added to line. For ratios up to 6:1. Furnished with either a.c. or d.c. motors of various types in sizes of ¾ hp. and up. Multi-speed and adjustable-speed motors may be used. Entire reduction in one pair of gears. Feet cast integral with gear housing. Ball bearings throughout. Bulletin 402.

Reliance Electric & Engrg. Co., 1042 Ivanhoe Rd., Cleveland, Ohio.

Condensate Return Unit

"Condensator" returns water of condensation to boiler from open return line heating systems independently of boiler pressure. This is accomplished without any change in operating conditions of system, and without air-binding system or admitting steam to return side. Unit is installed near boiler as high above water line as possible. Water of condensation flows into Condensator, and rising, causes valve on steam line between boiler and Condensator to open, thus equalizing pressures in boiler and Condensator and allowing water collected in Condensator to return to boiler by gravity. Various capacities for installations of all sizes. Steam supply line to unit, or what is termed "equalizing line," between boiler and Condensator, should be provided with stop valve and strainer. Thus, strainer is attached to unit when supplied. Has removable screen to permit easy cleaning. Vent trap for air also provided. All working parts bronze and totally inclosed. Bulletin.

Barnes & Jones, Inc., 128 Brookside Ave., Jamaica Plain, Boston, Mass.



Self-Sealing Ring Packing

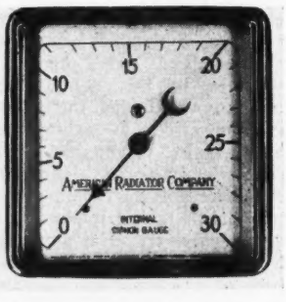
"Par" ring packing seals automatically, adjusting to pressure changes. Pressure dissipated on power stroke through action of shoulder molded in each ring, which forces lips to sides of stuffing box and to rod. Responds sensitively to pressure changes, and needs little gland pressure. No leakage on power stroke and no gripping of rod or plunger on return. Furnished in sets of thin rings for hydraulic service (style 860) or high-temperature service (Style 870). Bulletin.

Linear Packing & Rubber Co., 6400 State Road, Philadelphia, Pa.

Larger-Size Pumping Unit

"Motorpump" complete pumping unit, with built-in electric motor and pump rotor on same shaft, is now built in 26 sizes ranging from ¾ to 30 hp., and from 5 to 1,000 gpm. capacity. Certain sizes are two-stage units; others are fitted with self-priming attachment. Catalogs Nos. 7464 and 2070.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y.



Square-Case Pressure Gages

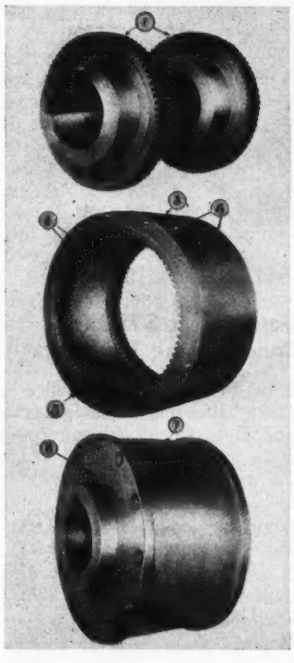
Various types of pressure and combination gages now in square cases. Steam pressure gage with or without internal siphon, or compound pressure and vacuum gage with or without retard features and other combinations. Bottom or back connected. Also with adjust-

able flanges for concealed mounting.

United States Gauge Co., 44 Beaver St., New York, N. Y.

Torque-Ring Couplings

Torque carried by lubricated surfaces through solid-metal parts from hub to hub. End plates (6) and gaskets (5) form dust- and moisture-proof enclosure with center sleeve to contain a supply of oil adequate for long periods of operation. Oil filling hole at (7). Hubs (1) are alike with toothed flanges at their centers, making it possible to turn them end for end and obtain new driving surfaces.



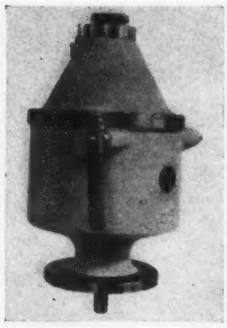
Torque rings (2) are two solid steel with teeth cut on inside and outside. These are loosely held in place within cover sleeve (3) by screws (4) and handled as a single unit. By removing either end plate, cover sleeve and torque rings can be moved in opposite direction to line up initially or to check alignment from faces of inner hubs. Fifteen sizes for shafts from 1⅞-in. to 12-in. diameter with ratings from 22½ to 4,840 hp. per 100 r.p.m. Bulletin.

Smith & Serrell, 20 Washington Place, Newark, N. J.

Waterproofing for Walls

"Stonhard Stonehide" liquid for brushing or spraying on walls to prevent penetration of moisture. Is transparent and will not discolor surface treated.

Stonhard Co., 401 N. Broad St., Philadelphia, Pa.

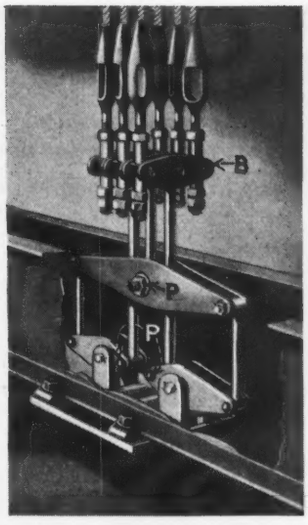


Engine Governor

For diesel, gas and steam engines, this entirely enclosed Type T governor has internal speed regulator. Powerful, sensitive and stable, giving uniformity of action throughout motion of control lever. Two sizes, each with two designs, one for generator service, mills, etc., other for compressor, pipeline and dredge service, etc. Generator unit has speed regulator for plus or minus 5% speed change from normal for synchronizing. Compressor unit has speed regulator for 100% speed change. Control lever can be mounted on either side and at any position in full circle. Weights employ Massey principle of slots with a certain angularity to give uniform change of sliding-sleeve position per revolution change throughout stroke. Weights also balanced in three planes and held together by tension springs working through knife-edge bearings to studs on weights. Heavy parts are as near as possible to upper spindle bushing. Speed-regulator spring enclosed with governor and exerts desired downward thrust directly on weights, avoiding friction and wear of slip collar. Handwheel always at same height, permitting gear to be used for remote control. Roller bearings take up thrusts. Lubrication either independent or from engine system. Slip collar of oilless bronze.

Fluctuation (difference in revolutions from top to bottom of stroke, based on revolutions at midstroke) is less than 2%. If engine requires higher fluctuation, different overhead springs can be applied. Smaller size unit has work capacity of 10.5 in.-lb. (will handle 4 Bosch PF1C fuel pumps and connecting levers easily), larger 26.4 in.-lb. (will handle 6 pumps and levers with plenty of surplus power). Governors capable of controlling within ½ cycle for normal load changes. Paralleling two units readily accomplished. For no-load to full-load change, governor will hold engine within 3 to 5%, based on full-load speed.

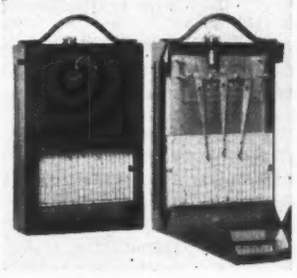
Massey Machine Co., 781 Pearl St., Watertown, N. Y.



Lever-Type Equalizer For Elevator Ropes

This automatic elevator-rope equalizer utilizes pivoted whiffletree levers to distribute loading and rope stretch takeup. This action gives load centering, with no tendency to crowd either guide rail. Equalizer for six ropes shown. Each of the three pairs of ropes connects to opposite ends of three equalizing bars *B*. These bars are pivoted at their centers and connect to pivot *P* in an equalizing lever system. This assembly of levers is connected to a supporting baseplate on which car-sling crosshead rests. Ropes are free to equalize load between them. Main pivot shafts bronze bushed, and all moving parts lubricated. Ultimate strength of each equalizer considerably in excess of any code requirements. No drilling for installation on existing cars, and easily installed.

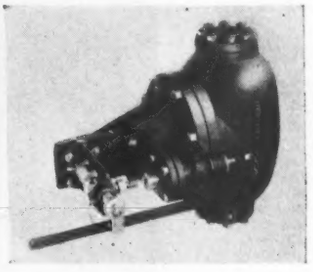
A. B. See Elevator Co., 419 Fourth Ave., New York, N. Y.



Humidity and Temperature Recorder

Portable, compact, this recorder for humidity, temperature and operation can be used in heating, ventilating, refrigeration, air conditioning and for industrial use. Charts of index-card file type giving records over 30 or 10-hr. periods. Time lines common to all three pens, for ease of comparison. Week's supply of charts, ink supply and spare pen also carried in same case. Chart size 3x5 in. Range 0 to 100% R.H., 0 to 100 deg. F. temperature, loads up to 8 amp. (inrush not above 30 amp.) on operation recorded. Also special low ranges. Instruments in one, two or 3-pen types. Bulletin K.

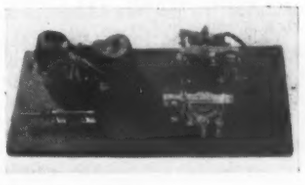
Julien P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md.



Ball-Bearing Remote Control

Controls liquid level in tanks, condensers, receivers and other vessels. Float chamber is equipped with full ball-bearing construction of stainless steel balls and races. Eliminates friction caused by liquid under pressure. It will operate valves at any distance up to 300 ft. and permits pressures up to 450 lb. Operating mechanism fully enclosed but easily accessible for adjustment. Grease-sealed stuffing box optional.

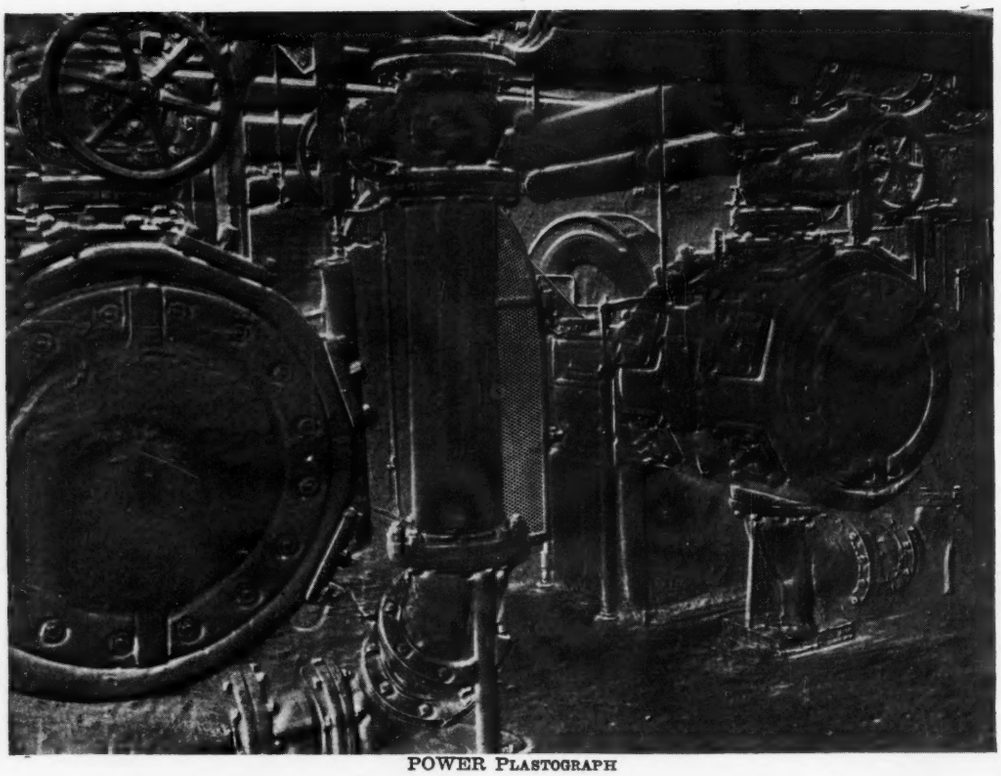
Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.



High-Speed Lowering Relay for Cranes

High-speed lowering relay for crane hoists increases lowering speed without reducing safety factor or minimizing control accuracy. Entirely automatic, being controlled by weight of load. When load is heavier than one-third capacity, relay automatically prevents speed increase. Photo shows ebony-asbestos panel mounted with single-pole, single-throw knife switch and spring-closed contactor, below which are a normally opened circuit relay and standard, two-pole control-circuit relay. Can be applied to any d.c. motor-operated crane equipped with series motors and dynamic lowering control. Available for hoist motors from 110 to 550 volts.

Harnischfeger Corp., 4497 W. National Ave., Milwaukee, Wis.



POWER PLASTOGRAPH

POWER LINES

Tribune Tower to Have 600-ton Steam-Jet Plant

The largest installation of unit-type air conditioners thus far will be in the 38 floors of the Chicago Tribune Tower. The system will include a central steam-jet refrigeration plant, with capacity equivalent to 600 tons ice-melting capacity per day, and approximately 400 individual air-conditioning units. The units will replace the cast-iron radiators which heat the building at present.

The central refrigeration plant is located in the basement and will circulate chilled water to the unit conditioners in summer. The present heating plant will supply steam for heating in winter. Each unit conditioner cabinet houses electric fans for circulating the air, filters for cleansing it, sprayers for humidifying it, steam coils for heating it, and chilled water coils for cooling and dehumidifying it.

Giant Cranes for Boulder Dam

A contract for four 300-ton and one 50-ton electric traveling cranes, to be installed in the power house at Boulder Dam, has been awarded to Harnischfeger Corp. The four 300-ton units are of the double-trolley power-house type and have a span of 64 ft. and a lift of 70 ft. Truck bodies and trolley frames are to be of welded construction. Two of the 300-ton units will be installed in each wing of the power house for the purpose of handling the huge generator rotors.

The award, largest electric-crane order during the past five years, totals about $250,000.

Propose Credit Banks For Industry

The setting up of twelve industrial credit banks is the aim of a recent bill introduced in congress. It is proposed to establish a credit bank in each Federal Reserve district, subject to regulations prescribed by the Federal Reserve Board. A majority of directors for each credit bank must be actively engaged in some industrial pursuit in the particular Reserve district.

Under the bill, the credit banks would be empowered to make loans to industry to mature within five years as well as to participate with commercial banks in making loans. Each such financing institution is to obligate itself for at least 20 per cent of any loss sustained by the credit banks upon any of the obligations from such financing institution. When an established industrial or commercial business is unable to secure financial assistance on a reasonable basis from the usual sources, the credit bank may make advances direct.

Interior Dep't. Gets $750,000 For Air-Conditioning Buildings

Allotment of $700,500 to the office of National Parks, Buildings and Reservations, Interior Department, for air-conditioning nine Federal Buildings in Washington, D. C., will be used as follows:

State Department	$ 75,000
Internal Revenue Building ..	45,000
Commerce Building	16,000
Old Land Office Building ...	9,000
Agriculture Department Buildings	348,000
Navy Building	49,000
Munitions Building	31,000
Treasury Building	17,500
Interior Building	110,000

Work on the projects will be started in the near future, as plans have practically been completed.

Ford Builds High-Pressure Plant in England

Ford Motor Company is building the first 1,400-lb. pressure power station in England to serve its new plant at Dagenham, just outside of London. It will have a generating capacity of 31,250 kw. and also contains two turbo-blowers, each capable of supplying 50,000 c.f.m. of free air at 30 lb. pressure to a 500-ton blast furnace.

The three sectional-header boilers with Bailey water walls have a normal capacity of 99,000 lb. per hr. and a maximum capacity of 205,000 lb. per hr. Interdeck superheaters raise the steam to 750 deg. F. Economizers and tubular air preheaters are provided. One of the boiler furnaces

is provided with special retorts for burning city refuse from London. This and the other units are designed to be fired either by pulverized coal, blast-furnace gas, or coke-oven gas.

The 3-cyl. tandem-compound turbine drives a main generator of 34,400 kva. and a 3,570-kva. auxiliary generator. The main generator provides 50-cycle 3-phase current at 11,000 volts for factory use, and the auxiliary unit generates at 3,300 volts.

A 3,750-kw. turbine generator operating on steam at 200 lb. pressure is provided to supply power over week-ends when the manufacturing plant is shut down. This is a 9-stage unit and receives steam from either the exhaust of the high-pressure cylinder of the main unit or from an independent battery of lower-pressure boilers. These two supplies are inter-connected through pressure regulators so that if the pressure of the extracted steam drops, demand can be met from the low-pressure boilers.

Up to 155,000 lb. of steam per hr. can be extracted from the high-pressure cylinder exhaust, which is maintained at 200 lb. per sq.in. gage. Of the extracted steam, 50,000 lb. per hr. may be required for driving the turbo-blowers. This steam, together with the steam for the intermediate cylinder, passes through a reheater where it is heated by 1,200-lb., 725-deg. steam. The rest of the 200-lb. steam is used in the factory.

Steam bled from the low- and intermediate-pressure cylinders and 200-lb. exhaust from the high-pressure cylinder heats feed water to 376 deg. F. at all loads. Make-up is provided by two evaporators.

Newton, Mass., Modernizes Municipal Pumping Station

Newton, Mass., has just completed replacement of the old equipment in its pumping station. Water, supplied principally from wells, flows into a suction well in the pump room. Originally, this room included a 1-story and basement layout with a vertical, cross-compound, 5-m.g.d. pump installed about 1904 and a smaller horizontal-duplex pump dating from about 1882. The boiler room, slightly above grade, housed two 3,000-sq.ft. firebox boilers, hand-fired. At the time of their removal, they were still carrying the full 125-lb. boiler pressure for which they were designed, even though 42 years old.

The new pump room is at the grade of the old basement and includes three De Laval turbine-driven combined pumping and electric-generating units. Pumps are 4½-, 6-, and 8-m.g.d. capacity, with a 200-kw., 3-phase, 60-cycle, 4,000-volt generator on each unit. These generators supply power for station auxiliaries and for pumps on the well reservation, replacing power formerly purchased. Turbines operate at 235 lb. steam pressure with 150 deg. superheat and exhaust into waterworks-type surface condensers, producing 29 in. or better vacuum at all times. Average test duty of these three units was 191,000,000 ft.-lb. of useful work done per 1,000 lb. of steam supplied.

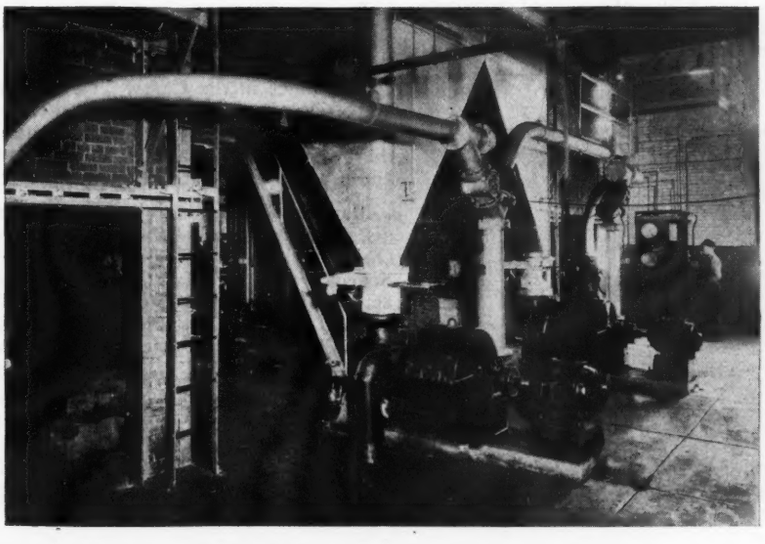
Boiler equipment consists of two 2,500-sq.ft. cross-drum boilers with pulverizers. Coal storage bins, over the pulverizers, include automatic weighing units. Feedwater equipment includes duplex plunger pumps, closed heater for condensing pump exhaust, and open deaerating heater using steam extracted from the turbines. Boiler efficiency on test for turbine load prevailing 60 per cent of the year was 79.2 per cent.

R. H. Ellis, water commissioner, originated the modernization plan, Weston & Sampson were consulting engineers, and D. D. Eames designed the new boiler-room layout.

Oil & Gas Power Meeting at Penn State College

As indicated in *Power* last month, the Oil & Gas Power Division of the A.S.M.E. will hold its annual Oil & Gas Power Meeting at Penn State College, State College, Pa., June 20 to 23. Two sessions will be devoted to engineering data on modern high-speed diesels. Papers will also be presented on piston rings, diesel fuel, and other phases of diesel and gas-engine design and operation.

Achema VII Exhibition of Chemical Plant and Apparatus will be held in Cologne, Germany, from May 18 to 27; 190,000 sq.ft. of space is provided in three halls. A number of engineering societies will hold meetings.



COMING MEETINGS

American Society for Testing Materials—Annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 25–29. C. L. Warwick, 1315 Spruce St., Philadelphia.

Association of Iron & Steel Electrical Engineers—Youngstown, Ohio, April 12. J. L. Kelly, Empire Bldg., Pittsburgh, Pa.

American Welding Society—Annual meeting, Engrg. Soc. Bldg., New York, N. Y., April 26.

American Institute of Electrical Engineers—Northeastern District meeting, Worcester, Mass., May 16–18. Summer Convention, Hot Springs, Va., June 25–29. H. H. Henline, 33 W. 39th St., New York.

Edison Electric Institute—Atlantic City, N. J., June 4–7. B. F. Weadock, 420 Lexington Ave., New York.

National District Heating Association—25th annual convention, Rochester, N. Y., June 12–15. D. L. Gaskill, sec.-treas., Greenville, Ohio.

American Society of Mechanical Engineers—Petroleum Division, Tulsa, Okla., May 14–16. (Also International Petroleum Exposition). Hydraulic Division, University of Calif., June 19-21. Oil & Gas Power Division, Penna. State College, State College, Pa., June 20–23. Applied Mechanics Division at 4th Intntl. Congress of Applied Mechanics, Cambridge, England, July 8–9. Semi-annual meeting of Society, Cosmopolitan Hotel, Denver, Colo., June 25–28. Headquarters—29 W. 39th St., New York, N. Y.

A.S.T.M. Plans Tests On Steel and Coal

At the Spring Group Meeting of the American Society for Testing Materials in Washington, D. C., March 5-9, a number of subjects of interest to power engineers were discussed. The present specification for boiler steel, 45,000 to 55,000 lb. per sq.in. tensile range, was retained by Committee A-1 on Steel. The Subcommittee on Boiler Steel offered a consolidation of the Standard Specifications for Boiler and Firebox Steel for Stationary Service and for Steel Plates of Flange and Firebox Qualities for Forge Welding, which was referred to the Welding Subcommittee. Another change by this committee concerned new specifications for electric-fusion-welded steel pipe, 18-in. in diameter and over, for high-temperature and high-pressure service. Three grades of plate for use in making the pipe are given, minimum tensile strengths being 45,000, 50,000 and 55,000 lb. per sq.in., and radiographic examinations of the pipe are required. Each length of pipe is to be tested to a hydrostatic pressure which represents a stress of 75 per cent of the minimum specified yield point. Omission of requirements for flanges for forge welding was also recommended.

Committee D-5 on Coal and Coke is planning to conduct a round-robin series of tests on several different coals covering a wide range of hardness, using different methods, to study pulverizing characteristics of coal.

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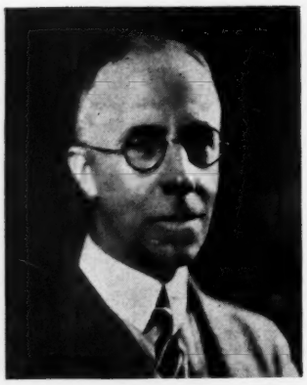
According to an announcement by J. G. Glassco, manager of the Winnipeg Hydro-Electric System, two new units will be needed at Slave Falls, these to be 12,500-hp. units to cost $1,500,000. At the present time the entire output of Pointe de Bois and Slave Falls plants, as well as the full amount of power called for under the hydro contract with Winnipeg Electric Co., is in use. Two-thirds is being used for the electric boilers of the civic central heating plant to generate steam.

PERSONALS



H. D. James, former consulting engineer of Westinghouse Electric & Mfg. Co., has opened an engineering consulting service, specializing in industrial and building problems. The organization offers technical information, cost analysis, and design of equipment to manufacturers without technical staffs. Experienced engineers working under Mr. James' supervision are available for special assignments, including electronic and air-conditioning applications. Mr. James is a registered engineer in Pennsylvania; a technical graduate; an original Fellow of the A.I.E.E.; and past president of the Engineers Society of Western Pennsylvania. Headquarters are at 1532 Gulf Bldg., Pittsburgh, Pa.

B. F. Bilsland has been made manager of the Chicago Office of Allis-Chalmers Mfg. Co., at 20 N. Wacker Drive. Arch J. Cooper has been appointed assistant manager of the New York office, 50 Church St., of which A. F. Rolf is district manager.

Ralph G. Caulley has joined the Detroit sales office of Republic Steel Corp., Youngstown, Ohio.

A. D. Blake, for many years managing editor of *Power,* and more recently associated with Combustion Engineering Co., New York, N. Y., has been placed in direct charge of the newly organized Technical News Service of that company.

J. H. Ferry, chief engineer of Potomac Electric Power Co., Washington, D. C., was appointed vice-president of that organization at a recent meeting of the board.

F. E. Harrell has been made assistant chief engineer of Reliance Electric & Engrg. Co., Cleveland, Ohio. J. L. Van Nort, former New England and Cincinnati representative, has been transferred to the Chicago office.

Wilbur G. Hudson has been appointed chief engineer of Link-Belt Company's Pershing Road Plant in Chicago.

Leo W. Grothaus, of Milwaukee, and **Robert M. Gaylord,** of Rockford, have been elected to the executive committee of Machinery & Allied Products Institute. The Institute, which has been leading code deliberations of the capital goods industry of the country, is headed by John W. O'Leary, of Chicago.

Mr. Grothaus is an officer of Allis-Chalmers Mfg. Co. Mr. Gaylord is president of Ingersoll Milling Machinery Co.

I. E. Moultrop, chief engineer of the Boston Edison Co., is working on a plan under which a combined group of Boston engineers may take out membership in American Engineering Council.

Frank B. MacMillin has been elected president and general manager of Hydraulic Press Mfg. Co., Mount Gilead, O. Howard F. MacMillin was elected vice-president and assistant general manager. Walter G. Tucker, son of the founder of the company, was advanced to chairman of the board.

Emilio N. MacKinney has been appointed sales representative for Sarco Co., Inc., in Mexico City. Mr. MacKinney is a Mexican, educated in the United States, and a graduate of Massachusetts Institute of Technology.

William McClellan, president of Potomac Electric Power Co. and past president of the A.I.E.E., will discuss the history of American Engineering Council before the A.I.E.E. on its 50th anniversary in May.

Chas. R. Neeson, Harry L. Galson, Hans K. Steinfeld, and **Henry C. Heller,** engineers connected with Baldwin-Southwark Corp., Philadelphia, Pa., were awarded John Scott medals for their work in developing the De La Vergne air conditioner. The medals are awarded annually for the outstanding scientific achievement of the year.

Charles F. Norton, formerly vice-president and general manager of Howell Electric Motors Co., has been appointed general sales manager of the Louis Allis Co., Milwaukee.

Walter E. Peterson, formerly of the Magnolia Metal Co., has joined the Chicago plant of United American Metals Corp. as manager of the Babbitt Metal Department.

J. F. Roche, executive vice-president of Binks Mfg. Co., Chicago, Ill., has been appointed a member of the Illinois State Advisory Board of the National Emergency Council.

J. Verner Scaife, Jr., has been elected president of Wm. B. Scaife & Sons Co., Oakmont, Pa. He succeeds Alan M. Scaife, who will continue as vice-president.

Walter Siegerist has been elected president of The Medart Co., St. Louis. Walter R. Medart was elected chairman of the board. Mr. Siegerist, general manager of the company for the past two years, was formerly connected with Midwest Piping & Supply Co., St. Louis.

Strauss Portrait

Dr. Lewis B. Stillwell, consulting engineer of New York, N. Y., was awarded the 1933 Lamme Medal of the A.I.E.E. for his distinguished career in connection with "design, installation, and operation of electrical machinery and equipment."

E. W. Wagenseil has been appointed general sales manager of Hagan Corporation, Pittsburgh, Pa., and its subsidiaries. Mr. Wagenseil was in charge of air preheater sales for Blaw-Knox Co., before joining Hagan Corp.

A. C. Willard, past president of the A.S.H.V.E., has been elected president of the University of Illinois. He is well-known for his research studies and was a consultant on ventilation for the Holland Tunnel under the Hudson.

I. R. Hoffman, fuel engineer, Central Coal Co., is the author of the article, "Firebox Boiler Fired by Chain-Grate Stoker," on page 179 of this number. His name was inadvertently omitted in making up the page.

BUSINESS NOTES

Bradshaw & Co., 530 Fourth Ave., Pittsburgh, Pa., have been appointed representatives for DeWolf Furnace Corp., Rochester, N. Y.

Centrifix Corp., Cleveland, Ohio, has appointed M. F. Anders, Seattle, Wash.; Gordon & Finkbeiner Co., Portland, Ore.; Frank A. Phillips, Scranton, Pa.; and M. E. Soangberg Co., Peoria, Ill.; sales representatives.

L. L. Adcox Trade School, Portland, Ore., is installing one d.c. and two a.c. generators, all diesel driven, with supplementary panel board and instruments for its diesel course, recently started. A. C. Snyder, superintendent of the McMinnville municipal diesel plant, McMinnville, Ore., outined the practical course.

Babcock & Wilcox Tube Co. announces that the territory served by its Tulsa, Okla., sales office, of which C. J. Hochenauer is manager, has been enlarged to include the State of Oklahoma and southern half of Kansas.

H. Boker & Co., 101 Duane St., New York, N. Y., has recently gained the following representation: American Rolling Mills Co., Diamond Saw & Steel Co., and Michigan Products Corp.

Jeffrey Mfg. Co. has opened a Cincinnati office in the Carew Tower Bldg. and a Cleveland office in the Rockefeller Bldg. Lyle Martin will be in charge of the Cincinnati office and G. D. Francisco and J. R. Warren at Cleveland.

Maxfield Pease has been appointed district representative for the Cleveland, Ohio, territory for Goulds Pumps, Inc., Seneca Falls, N. Y. His office will be at 4614 Prospect Ave., Cleveland. The branch office in the Union Trust Building, Cleveland, has been discontinued.

William A. DaLee, 4829 Woodward Ave., Detroit, has been appointed district representative there. **Walter S. Bryde,** formerly in charge of the Detroit territory, has been given the western New York territory, working from 137 Linden Ave., Rochester.

Eastern Steam Specialty Co., New York, N. Y., has been appointed representative for H. O. Trerice Co., Detroit, in the New York district.

Rodney Davis, 624 Race St., Philadelphia, has been appointed distributor for Diamond roller chains and other equipment for the Philadelphia district by the Diamond Chain & Mfg. Co., Indianapolis.

T. C. Messplay, Kansas City, Mo.; Fairman B. Lee, Seattle, Wash.; Leinart Engrg. Co., Knoxville, Tenn.; and Engineering Sales Co., Holland, Mich.; have been appointed representatives for Hays Corp., Michigan City, Ind.

Maxfield Pease, 4614 Prospect Ave., Cleveland, Ohio has recently been appointed sales representative in that territory by D. E. Whiton Machine Co., New London, Conn.

Wilbin Instrument Corp. has opened offices at 40 East 34th St., New York, N. Y. Officers are: G. A. Binz, president; Clement Wells, vice-president; E. A. Ileman, director and chief engineer. Wilbin Instrument Corp. will manufacture a complete line of electrical control instruments.

Frank M. Young, 2636 N. 48th St., Milwaukee, has been appointed representative for Poole Foundry & Machine Co., Woodberry, Baltimore, Md. **J. B. Engineering Sales Co.,** New Haven, has been appointed representative in Connecticut.

Geo. S. Mepham Corp. (of Delaware) successor to Geo. S. Mepham & Co., (of Illinois) will maintain general offices at the same address, 2001 Lynch Ave., E. St. Louis, Ill.

L. A. Snider Engineering Corp., 605 N. Michigan Ave., Chicago, has been appointed representative of Elgin Softener Corp., Elgin, Ill. Offices will also be maintained in Indianapolis and Peoria.

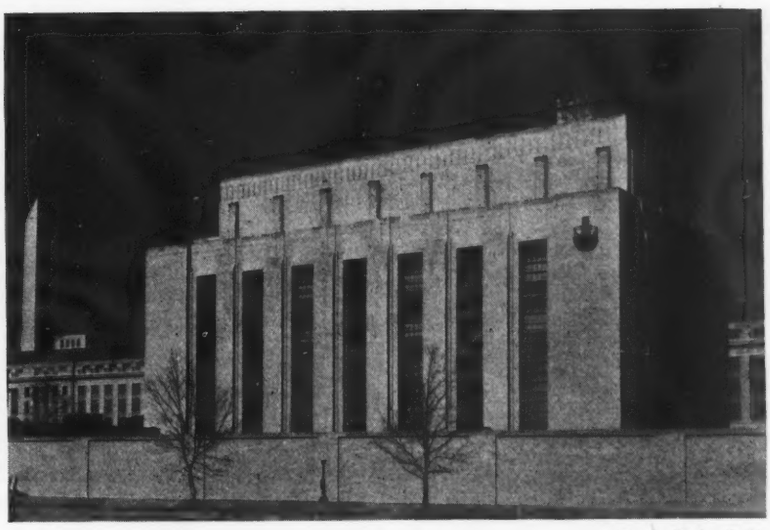
Jas. P. Marsh Corp., Chicago, Ill., has appointed A. W. Reynolds, 157 Baldwin Ave., Syracuse, N. Y., and J. M. Kane, P.O. Box 1552, Ft. Worth, Tex., as sales representatives.

Brown, Boveri & Co. Ltd., Baden, Switzerland, has formed the Swiss Electric Co. of Canada Ltd., to distribute the products of Brown, Boveri and Micafil A.-G., and other companies in Canada. Offices will be temporarily with Griswold & Co., Ltd., former distributors. R. S. Griffith has been appointed manager of the Canadian company.

Plant Rubber & Asbestos Works has moved its Los Angeles office and warehouse from 1701 North Main St. to 2121 East 25th St.

United American Bosch Corp. has moved its Detroit offices to the Stormfeltz-Lovely Bldg., Woodward & Grand Blvd.

Standard Oil Co. (Indiana) has made a number of changes within the organization. L. C. Welch has been appointed assistant general manager in charge of lubricating and technical departments; C. O. Wilson becomes manager of lubricating and industrial sales; L. G. Campbell manager of lubricating bulk sales and J. Clay Lee manager of railway sales.



Charles Phelps Cushing

WASHINGTON'S NEW CENTRAL HEATING PLANT

Supplying heat to Federal buildings in downtown Washington, the new $4,000,000 Triangle heating plant was cut in recently. Its six 25,000-sq.ft. boilers, capable of operating at 300 per cent rating, supplied 300,000 lb. of steam per day during the last cold wave. Because of legal restrictions, the six stacks are carried in ornamental housings. Coal is received by railway car on a below-grade siding under the wall in the foreground, and carried into the plant basement by conveyor belt. Steam is delivered through three mains, two 18-in., one 12-in. diameter. The plant will burn about 60,000 tons of coal a year and will serve 20 buildings, including the White House.

Debevoise Co., 968 Grand St., Brooklyn, N. Y., and 25 Broadway, New York City, has appointed Julio F. Sorzano as general sales manager. He was formerly with Standard Varnish Works and Toch Brothers, Inc.

Louis-Allis Co., Milwaukee, Wis., has appointed four new representatives, C. F. Cate, 212 N. Third St., Albuquerque, N. M.; Robert B. Soderberg, 196 Palm St., Hartford, Conn.; N. O. Lawyer, working out of the company's New York office at Room 385, 50 Church St.; and D. W. Connor, working out of the Cincinnati office at 1124 Chamber of Commerce Building.

John W. Lees, 52 Howe St., New Haven, Conn., has been appointed sales representative for Massachusetts, Rhode Island and Connecticut, for McClave-Brooks Co., Scranton, Pa.

Robins Conveying Belt Co., New York, N. Y., has acquired the coal and ore handling business of the Mead-Morrison Mfg. Co., Boston, and will operate it as the Mead-Morrison Division of Robins Conveying Belt Co., with offices at 15 Park Row, New York, N. Y. Equipment from the Mead-Morrison plant at East Boston, Mass., is being transferred to the Robins works in Passaic, N. J.

OBITUARIES

William S. Lee, 62, president of American Engineering Council, died March 24 at his home in Charlotte, N. C. A pioneer in electrical engineering theory and construction, Mr. Lee was a noted figure in the engineering field. The Catawba River plants in the Carolinas and the Saguenay River development in Quebec are some of the projects with which Mr. Lee was associated. He was a past president and fellow of the A.I.E.E., a member of the American Electro-Chemical Society, A.S.C.E., A.S.M.E., and a fellow of the Engineering Institute of Canada.

Walter W. Reed, 62, electrical engineer in the Bureau of Yards & Docks, Navy Dept., died in Washington, D. C., Jan. 4.

Walter D'Arcy Ryan, 63, famous General Electric illuminating engineer, died at his home in Schenectady March 14. Mr. Ryan was well-known for his work in street lighting, floodlighting, and other illumination problems. He planned and executed the illumination of the Panama-Pacific International Exposition at San Francisco, in 1915, and the Century of Progress at Chicago in 1933. Mr. Ryan, born at Kentville, Nova Scotia, was educated there and in Halifax. Upon completing his studies he came to the United States and was employed at the Lynn Works of the Thomson-Houston Electric Co. In 1896 he became superintendent of test men in the General Electric's West Lynn Works. In 1903 he was formally designated illuminating engineer.

Frank R. Wheeler, widely known engineer, died at his home on March 1. Mr. Wheeler was a graduate of Stanford University and a specialist in condensing equipment.

POWER NOTES

Construction will start shortly on a 106,000-kw. power plant at Meyertown, in the Transvaal, which will be South Africa's largest power station. The plant, to be known as the Klip generating station, is planned to have a capacity 6,000 kw. more than that at Witbank, the country's present largest station, and will cost $5,000,000.

STRAWS

Pointing the way business winds blow

Several compressor plants will be constructed by Industrial N[illegible]al Gas Pipe Line Co., an interest [illegible]ichigan Natural Gas Corp., Mc[illegible]easant, Mich., in connection wit[illegible] steel pipeline system for na[illegible] gas [illegible]ervice at Detroit, Flint, Pontiac and vicinity. Service estimated at close to 75,000,000 cu.ft. daily. Estimated cost, close to $4,500,000.

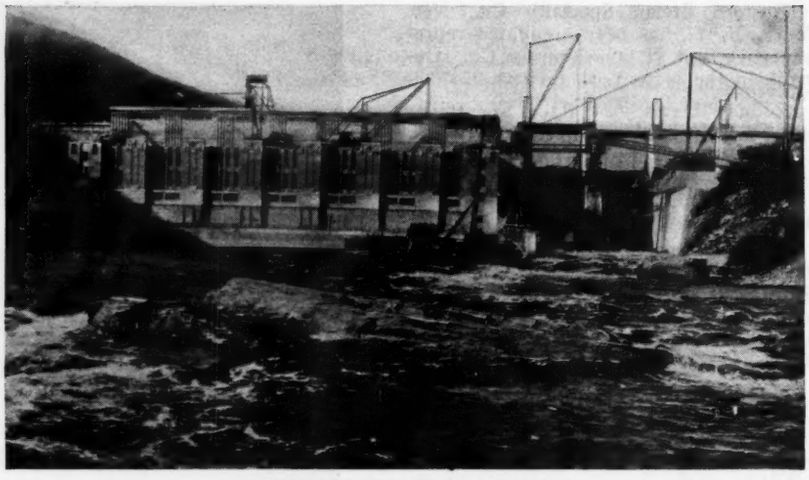
California, Mo., plans call for bids early in May for equipment for municipal light and power plant. Fund of $145,000 has been arranged. W. B. Rollins & Co., Railway Exchange Bldg., Kansas City, Mo., consulting engineers.

Cumberland, Md., has engaged Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., to make surveys and estimates of cost for a light and power plant. Report is expected this month.

Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until April 11 for continuous blow-down, water-softening and chemical feeding systems at Mare Island Navy Yard, San Francisco, Calif. (Specification 7610.)

Monitor Gold Mining Co., Amarillo, Tex., care of J. F. Bromert, Amarillo, president, lately organized, plans new power plant in connection with gold-mining operation. Fund of $750,000 is being arranged. R. J. Booth, Amarillo, secretary and treasurer.

Tucson, Ariz., has called a special election early this month to approve a bond issue of $322,500, for a light and power plant, using diesel engine-generating units. Financing through Federal aid. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer .



RAPIDE BLANCHE IS CUT IN

The first of the six 40,000-hp. units in the Rapide Blanche development of Shawinigan Water & Power Co.'s St. Maurice River system has taken load. Three more will be ready in May, bringing the station to 160,000 kw. and the company's capacity to 809,200 hp. in hydro plants. This plant is 30 mi. above La Tuque, Que., Canada.

Large steam-electric power plant will be constructed by Adolph Busch, Inc., 1109 Title Guaranty Bldg., St. Louis, Mo., recently organized, in connection with new multi-unit brewing plant at Broadway & Catalan St., to include two 2,500-sq.ft. water-tube boilers, with automatic stokers, boiler-feed pumps and accessory equipment; diesel engine-generator units with auxiliaries. All brewing equipment motor-driven. Also includes refrigerating plant, with three 80-ton refrigerating machines, compressors and auxiliary equipment. Cost close to $1,000,000. George E. Wells, Inc., Security Bldg., St. Louis, consulting engineer.

Natural Gas Service Corp., Jackson, Miss., is planning for a large natural-gas system in central part of State, totaling about 8,200 mi. of welded steel pipeline for main trunk service. Financing through Federal aid for $144,000,000 is being arranged.

Corning, Ia., has rejected bids recently received for municipal electric light and power plant, and expects to ask new bids for equipment early in May, including three diesel engine-generator units, fuel-oil tanks, etc. Fund of $160,000 has been secured. Young & Stanley, Inc., Muscatine, Ia., consulting engineer.

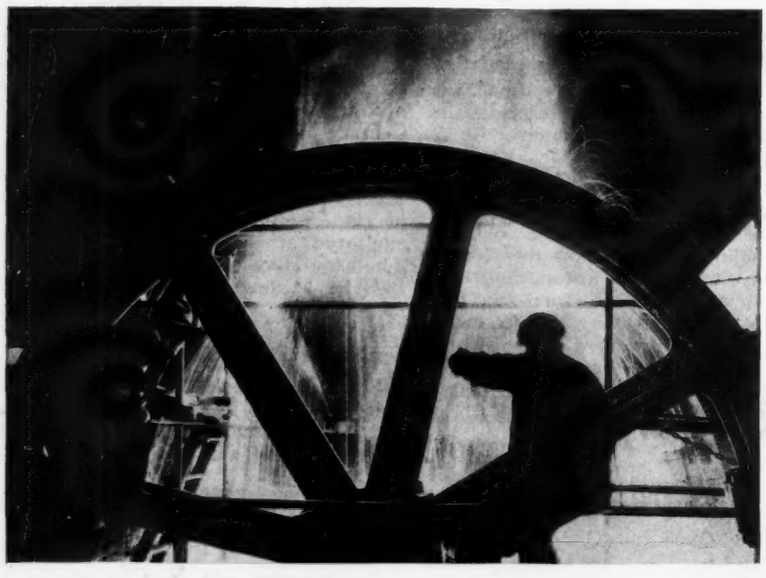
Vicksburg, Mich., is completing surveys and estimates of cost for a light and power plant. Francis Engrg. Co., Saginaw, Mich., consulting engineer.

Western Carolina Teachers' College, Cullowhee, N. C., is considering extensions and improvements in its hydro-electric power plant. E. J. Duckett is engineer.

Ely, Minn., will complete plans in the spring for a steam-electric generating plant for electric light and power, and central steam heating service. Entire project is estimated to cost $1,700,000. Frederick C. Perry, Columbia Bldg., Duluth, Minn., consulting engineer.

Bradford, Ohio, has plans maturing for a municipal electric light and power plant, for which financing for $83,000 is being concluded. It is expected to call for bids for equipment at early date. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

Steam power plant will be constructed by M. K. Goetz Brewing Co., Sixth & Albemarle Sts., St. Joseph, Mo., at proposed new brewing plant on tract of land recently acquired at Indiana Ave. & 17th St., Kansas City, Mo. Entire project will cost about $400,000. Brewery equipment to be electric-operated.



WELDING SAVES THE DAY—AND SHAFT

A serious transportation delay threatened San Francisco's Market Railway Co. recently when the 18½-ft. main driveshaft at the power house let go on a Saturday afternoon, tying up three railway lines. The break occurred at a shoulder on the center drive-gear seat. The railway's welding gang, with a representative of Metal & Thermit Corp., worked through until Monday morning, and completed welding in time for cars to start on regular Monday schedules. Only minor dismantling was required, since the repair was made with the shaft in place. The welded shaft was less than 1/32-in. out of line.

Middle Loup Public Power & Irrigation District has plans in progress for a new hydro-electric power and irrigation project on the Loup River, vicinity of Loup City, Neb. It is proposed to construct power dam, generating station, two main canals for irrigation purposes, and group of electric-operated pumping stations, estimated to cost $1,500,000. Application has been made for a Federal loan and grant in that amount. H. E. Henningsen, Union State Bank Bldg., Omaha, Neb., consulting engineer. Walter Gibbon has been elected president, and D. E. Wynn Jones, Omaha, general manager.

Russia is planning two hydro-electric projects, one the Volga-Don canal, on which work has started, and a station in Ulbinsk, Siberia, which will generate energy for industries at Ridder.

Santee-Cooper bill has been sent to the Senate by the South Carolina House. It provides for a state authority to borrow $34,000,000 from the PWA to develop the navigation and power plan as a state project.

Richmond, Va. will consider the question of establishing a city-owned electric plant at a meeting of the committee of council April 19. A bond issue of $5,000,000 is advocated to cover the cost of construction.

Wellman, Ia., is planning to build a municipal power plant costing approximately $85,000. A 350-hp. diesel engine is to be installed.

Some larger PWA loans and grants for power and light projects are: Florence, Ala., $436,000; Ft. Collins, Col., $738,000; Middlesboro, Ky., $328,000; Northampton, Mass., $360,000; Cushing, Okla., $350,000; Knox County, Tenn., $2,600,000; Austin, Texas, $400,000.

Milford, Ia., voters have voted for a municipal light and power plant. They will seek a PWA loan of $80,000.

Kewanee, Ill., J. G. Thorne, engineer, is planning to install two 2,400-hp. diesels.

Grand Junction, Ia., has awarded to Fairbanks, Morse & Co., Chicago, Ill., an $85,000 contract for a diesel-powered municipal plant.

Winthrop, Minn., is planning a new municipal light and power plant. R. W. Richardson, St. Paul, Minn., engineer, is in charge of the project.

Coon Rapids, Ia., voted for a municipal light and power plant to cost approximately $114,000.

Albia, Ia., voted down the proposal to build a $636,000 municipal light and power plant there.

Albert Lea, Minn., has engaged Black & Veatch, Kansas City, Mo., to make a survey for a municipal light and power plant.

TVA has protested to the Federal Power Commission against granting the application of the Southern Industries and Utilities, Inc., for a license to construct a power project at Shannon Landing, Ky., on the grounds that it wishes to build the dam itself as part of its Tennessee Valley development. The commission has set a public hearing for April 16.

Russell, Kan., has purchased a 1,100-hp. diesel generating set for its municipal light plant.

Russellville, Ala., has requested a PWA loan of $148,000 with which to construct a municipal light and power plant. The request has been approved by the State advisory board and forwarded to Washington.

Independence, Ia., has secured a Federal grant of $17,700 to be credited to the purchase of a 750-hp. diesel engine for the municipal power plant, which now has two diesel units.

Jewell Cotton Mills, Thomasville, N. C., has installed a 940-b.hp., 5-cyl., 22x30-in. La Vergne diesel running at 200 r.p.m. for mill power.

Construction is to start in the near future on several developments on the Kanawha river. Kanawha Valley Power Co. will develop power at the government dams at Marmet and London, W. Va. Three units of 6,400 hp. each will be installed at each dam. The installation is to be ready by Dec. 1, 1935, and will cost about $4,000,000.

Two allotments have been mdae to Nebraska, one a loan and grant of $7,500,000 for the Platte Valley District Sutherland project, and the other a loan and grant of $7,300,000 for the Loup River District Columbus project.

Peru, Neb., will install two diesel-generating units, costing $37,899. Present equipment will be discarded.

Lapel, Ind., has voted favorably for the construction of a power and light plant and sewage system.

Greenwood County, S. C., is making an effort to secure a PWA loan for the development of a power site on the Saluda river. The proposal is to install three units of 7,500 hp. each.

San Angelo, Tex., has plans maturing for a new municipal electric light and power plant, estimated to cost about $900,000, with equipment. Financing is being arranged through Federal aid, and it is expected to begin work as soon as fund is available. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

FEDERAL ALLOTMENTS

To	For	Loan and/or Grant	Total, Thousands of Dollars
Power Plants, etc.			
Edinburg, Ind.	Power plant additions, inc. two 360-kw. gen.	L & G	82
Perkasie, Penna.	Boiler house	L & G	55
Missouri Valley, Ia.	Two diesel-gen. units	G	5.6
Bridgewater State Farm, Mass.	Inc. two 375-kva. turbo.-gen.	G	33
Medfield State Hosp., Mass.	Boilers, gen., refrig. equip.	G	62.5
Foxborough State Hosp., Mass.	Three 250-hp. boilers and refrigeration plant	G	30.6
Moorhead, Minn.	Boiler, coal- & ash-handling equip.	G	28
Montpelier, Ohio	Inc. 1,000-kw. turbo.-gen.	G	12.6
Peoria Co., Ill.	Inc. two gas engines	G	25
Waterworks & Pumps			
Newman, Ill.	Waterworks	L & G	50
Mt. Ida, Ark.	Waterworks	L & G	24
Austin, Tex.	Inc. sewage-treatment plant	L & G	500
North Vernon, Ind.	Waterworks imp.	L & G	25
New Canaan, Conn.	Inc. sewage plant pumping station additions	L & G	88
Quitman, Miss.	Waterworks	L & G	30
Ponca City, Okla.	Waterworks imp.	L & G	560
Kalamazoo, Mich.	Sewage-treatment plant	L & G	415
Cleburne, Tex.	Well and pumps	L & G	35
Goshen, Ind.	Inc. sewage pump stations	L & G	455
Rowlesburg, W. Va.	Waterworks imp.	L & G	16
Warsaw, Ky.	Waterworks	L & G	32
Guthrie, Ky.	Waterworks	L & G	77
Lawrenceburg, Ind.	Inc. sewage-pump stations	L & G	59
Lowell, N. C.	Waterworks imp.	L & G	47
Sevierville, Tenn.	Waterworks	L & G	96
Oak Hill, Ohio	Waterworks	L & G	100
Suffern, N. Y.	Inc. sewage-pump stations	L & G	265
Sedan, Kan.	Waterworks imp.	L & G	90
Copeland, Kan.	Waterworks	L & G	23
Cotton Plant, Ark.	Waterworks	L & G	60
Kalamazoo, Mich.	Inc. pumping plant	L & G	23
Rocky Mount, N. C.	Waterworks imp.	L & G	310
Calico Rock, Ark	Waterworks	L & G	40
New York Mills, Minn.	Waterworks	L & G	34
Sherburne Co., Minn.	Pumping station	G	2.5
Wheaton, Minn.	Waterworks imp.	G	5.7
Litchfield, Minn.	Waterworks imp.	G	2.6
Jefferson, S. C.	Waterworks	L & G	26
Williamston, S. C.	Waterworks	L & G	135
Steelville, Mo.	Waterworks	L & G	44
Slidell, La.	Inc. sewage-pump station	L & G	9.5
Cedarburg, Wis.	Inc. pumping equip.	L & G	31
Trinity, Tex.	Piping for water dist.	L & G	24
Seiling, Okla.	Waterworks	L & G	28
Percy, Ill.	Waterworks	L & G	35
Hornersville, Mo.	Waterworks	L & G	30
Royal, Ia.	Waterworks	L & G	18
Hardin, Ill.	Waterworks	L & G	42
Tewksbury (Mass.) State Infirmary	Inc. wells, pumphouse & equip.	G	21.5
Salem, Ore.	Waterworks	add'l	1,000
Lansing, Ill.	Waterworks imp.	L & G	60
Holly Hill, S. C.	Waterworks	L & G	34
Gretna, Va.	Waterworks	L & G	43
Dillwyn, Va.	Waterworks	L & G	28
East Rochester, N. Y.	Waterworks imp.	L & G	80
Vernon, N. Y.	Waterworks	L & G	50
Algonac, Mich.	Waterworks imp.	L & G	56
Elba, N. Y.	Waterworks	L & G	48
Stringtown, Okla.	Waterworks	L & G	34
Cheyenne Wells, Colo.	Waterworks imp.	L & G	11
Fairport, Ohio	Waterworks imp.	L & G	95
Kilmarnock, Va.	Waterworks	L & G	50
West Chester, Penna.	Waterworks imp.	G	49
Walbridge, Ohio	Waterworks imp.	L & G	13
Morganfield, Ky.	Waterworks imp.	L & G	23
Littleton, W. Va.	Waterworks	L & G	36
Burkeville, Va.	Waterworks	L & G	47
Odebolt, Ia.	Waterworks imp.	G	3.7
Total			**$6,003,800**

NEW BULLETINS

Compressors and Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. 8-page Bulletin L-611-S7, on Worthington compressors of the single horizontal, single-stage type, both steam- and motor-driven, with 11- and 13-in. stroke. 4-page Bulletin D-423-S11A, superseding D-423-S11, on Worthington power pumps of the vertical, triplex, single-acting type equipped with Worthington Multi-V-drive.

Condensate—Nason Mfg. Co., 71 Fulton St., New York, N. Y. 20-page Catalog, "The Solution of Your Condensation Problem," describes complete line of steam traps and other specialties, including all types, such as buckets, ball float return, etc., including complete explanation and giving applications in various industries.

Flexible Couplings—D. O. James Mfg. Co., 1114 W. Monroe St., Chicago, Ill. 4-page bulletin on flexible coupling, also two new 2-page bulletins, one on herringbone gears, other on speed-changing devices. Also 4-page on speed reducers.

Graphic Instruments—Esterline - Angus Co., Indianapolis, Ind. 4-page Bulletin No. 1033, "Graphic Instruments Reduce Cost of Manufacturing Ice 13%." 2-page Form 427, "Save Time and Trouble by Using these Handy Devices," lists such units as chart inspectors, portable current transformers, handy connectors, compression pen filler, etc.

Hard-Facing—Haynes Stellite Co., Kokomo, Ind. 95-page "Hard-Facing With Haynes Stellite Products—494 Ways to Save Money," includes discussion of hard-facing gas-engine valve seats, clutch pressure plates and fingers, tappets, pump shafts, gate and globe valves, gas and oil needle valves, and nozzles, pulverizer hammers, and boiler-tube cleaners, etc., including a discussion of oxy-acetylene and electric arc applications.

Hoists—Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis. Bulletin No. RH-1 discusses application of hoists to both general and specific problems. Illustrated in color with photographs of installations and diagrams explaining construction and operation. Includes ratings and operating ranges for Type "R" hoists.

Radiator Traps—Sarco Co., Inc., 183 Madison Ave., New York, N. Y. Folder, "New Radiator Traps for Old," tells how building owners and managers save large sums on fuel bills by modernizing heating systems with radiator-trap replacement units.

Strainers—Elliott Co., Jeannete, Pa. Revised Bulletin A-6, "Twin Strainers," 24 pages, inludes units for low- and high-pressure service, compact unit, multiple-basket unit, motor-operated units in larger sizes; also twin oil strainers and single strainers.

Valves—Rigby Mfg. Co., Inc., 716 High St., Sharon, Pa. 6-page folder, "Mehle Precision Valve for Fuel Oil and Natural Gas."

Compressed-Air Turbines—Mining Engineering Co., Ltd., Worcester, England. 16-page illustrated booklet describing "Meco" compressed-air turbines.

V-Belt Drives—T. B. Wood's Sons Co., Chambersburg, Pa. 12-page booklet giving overload requirements, etc.

Indoor Oil Circuit Breakers—General Electric Co., Schenectady, N. Y. GEA 704D. Oil circuit breakers for use on moderate-capacity systems.

Centrifugal Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. 4-page bulletin, Type UB, two-stage volute pump.

Texsteel Sheaves—Allis - Chalmers Mfg. Co., Mliwaukee, Wis. Data on sheave diameters, number of grooves, bores and other data.

Rotary Pumps — Roots - Connersville Blower Corp., Connersville, Ind. 4-page descriptive bulletin and data on cycloidal rotary pumps.

Heavy-Duty Flooring—Continental Asbestos & Refining Co., New York, N. Y. Descriptive bulletin of "Stonoleum," repair or new floor materials.

Flow Meter—Foxboro Co., Foxboro, Mass. Descriptive bulletin on mechanical construction.

Flexible Couplings—Dominion Engineering Co., Ltd., Montreal, Canada. Leaflet on small-size "Gearflex" couplings.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ariz., Tucson—City plans diesel power plant. $325,000. Application for loan and grant approved by State Advisory Bd. and forwarded to Washington for final approval. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Conn., Wallingford—Boro, A. L. Pierce, Electric Light Dept., 32 South Elm St., plans rebuilding municipal electric power plant, destroyed by fire. $28,500.

Ga., White Cross—City plans light plant and waterworks system. $300,000. Application for loan and grant approved by State Advisory Bd. and forwarded to Washington for approval. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Ind., Fort Wayne—Bids Apr. 9, by Bd. P. Wks., City Hall, power plant equipment, incl. switchboard, cell structure, wiring, circulating pump motor controller, 440 volt motor starters, power distribution cabinet No. 6, lighting transformers, Div. 1; underground duct and manhole system. 13,800 volt circuits, 2,400 volt circuits, 440 volt motor circuits, field circuits, operating circuits, grounding, building lighting circuits. $45,000. Froehlich & Emery Eng. Co., 410 2nd Natl. Bank Bldg., Toledo, O., engrs.

Ia., Corning—City rejected bids Mar. 12, electric power plant. Young & Stanley, Inc., Muscatine, engrs.

Kan., Burr Oak — City plans light plant. $50,000. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs. Loan and grant approved by State, forwarded to Washington for final approval.

Kan., McPherson—City plans nearing completion and soon takes bids power plant. $210,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Kan., Osawatomie — City plans water and light plant. $165,000. Application for loan and grant approved by State, forwarded to Washington for final approval. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, Mo., engrs.

Kan., Washington—City plans light plant. $90,000. Loan and grant approved by State and forwarded to Washington for approval.

Md., Cumberland—City Comrs. plan electric light plant. Will select engineer to make survey.

Mass., Athol—Town, Bd. Selectmen, 584 Main St., plans municipal power and light plant. $30,000 or more. Architect not appointed.

Mass., Methuen — Town, Electric Light & Power Dpt., Town Hall, A. A. Thompson, chn. Bd. Selectmen, plans light and power plant. Engineer not appointed.

Mass., Onset—Onset Fire Dist., E. H. Eldredge, Town Hall, plans municipal lighting plant. $30,000. Engineer not appointed.

Mich., Saginaw—Bd. Supervs. Saginaw Co., R. C. Weber, chn., plans by Frantz & Spence, Saginaw, modern detention home for juveniles, incl. power plant and water system. $225,000.

Minn., Ely—City plans municipal water and light plant improvements, incl. chemical storage room addition, dry chemical feed room, office and laboratory, and installing treated water pump. Voted $74,000 bonds for same. $74,000 allotted by P.W.A. A. O. Knutson, city clk.

Minn., Moorhead — R. D. Thomas, consult. engr., 1200 2nd Ave. S., Minneapolis, submitted report to City Council stating it would take $342,365 to adapt the plant for central heating purposes, $372,344 to construct new power plant equipped with heating facilities at a downtown location and $92,000 to make necessary repairs at present plant.

Minn., St. Paul—City defeated proposal to issue $10,230,000 bonds for municipal light and power plant. G. M. Shepard, city engr.

Mo., Centralia—City plans power plant improvements. $60,000. Applied for loan under P.W.A. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, engrs.

Mo., Frederickston—City plans power plant. $135,000. Loan and grant approved by State Advisory Bd. and forwarded to Washington. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, Mo., engrs.

Mo., Moberly—City, O. A. Svoboda, clk., election Apr. 24, $700,000, for altering and constructing power plant addition, installing two 236 hp. boilers, two 2,000 kw. turbo-generators and electric distribution system. Russell & Axon, 4903 Delmar Blvd., St. Louis, engrs. P.W.A. allotted $700,000 funds.

Mo., Monroe City—City plans light plant improvements. $60,000. Application for loan and grant approved by State Advisory Bd. and forwarded to Washington for final approval. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engrs.

Mo., Rolla—Gasconade River Power Co., 1105 R. A. Long Bldg., Kansas City, plans hydro-electric dam and power plant on Gasconade River between Arlington and Jerome, Phelps Co., near here. Applied for $8,750,000 loan and grant under P.W.A. D. A. Dean, 605 R. A. Long Bldg., Kansas City, engrs.

Neb., Oak — Southern Nebraska Power & Light Co. plans electric power plant. $80,000 or more. Engineer not appointed.

Neb., Peru—City plans improving light plant. $37,899. Seeking loan and grant under P.W.A. State Advisory Board approved project. R. Fulton, 2327 South 19th St., Lincoln, engr.

N. Y., Albion—Village Bd. Trustees, plans municipal electric light and power plant. $100,000 or more. L. Reynolds, Geneva, engr.

O., Akron—City, I. S. Myers, mayor, preliminary surveys municipal light plant. $1,500,000. Burns & McDonnell Eng. Co., 417 East 13th St., Kansas City, Mo., engrs.

O., Dover—City retained W. C. Kammerer, Cleveland, as engineer for construction power and light plant. $100,000 appropriated by council for same. Seeking $20,000 P.W.A. loan.

O., Sandusky—City plans municipal light plant. $1,000,000 loan and $400,000 grant approved by State Advisory Bd. P.W.A. Froelich & Emery Co., 2nd Natl. Bank Bldg., Toledo, engrs.

O., Wadsworth—Village, J. H. Derr, mayor, preparing survey to determine cost of municipal light plant. R. Husselman, 310 Hippodrome Bldg., engr.

Okla., Cushing—City plans municipal light and power plant. $280,000 voted.

Pa., Myerstown—Election May 15, for voting for municipal light plant. $125,000. G. W. Scutt, 217 Waverly St., Shillington, engr.

Pa., Pottstown — Borough Council has appointed G. W. Scutt, 217 Waverly St., Shillington, as engineer, to make survey of borough for purpose of determining feasibility of municipal light plant.

S. C., Rock Hill—City, T. C. Marshall, mayor, seeking P.W.A. loan to finance construction 4,000 kw. power plant, incl. 2 units of 2,000 kw. each and calls for 1 of 3 types of plant, steam, diesel or hydro-electric. $529,000.

Texas—U. S. Eng., Wash., D. C., sketches constructing irrigation and power development on Rio Grande River, incl. 3 storage dams in Big Bend Dist., completing flood control program in Lower Valley, constructing power plant near Roma, and drainage lands adjoining river. $50,000,000.

Tex., San Angelo—City plans power plant. $990,000. Application for loan and grant approved by State Advisory Bd. and forwarded to Washington for approval. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, Mo., engr.

Va., Danville—Citizens voted down proposal to authorize town council to borrow $3,000,000 loan and grant from P.W.A. to construct hydro-electric plant.

Wash., Pullman — Bd. Regents Washington State College, bids about Apr. 14, power house, incl. 2 boilers, turbine and generator, on campus. $80,000. S. A. Smith, Pullman, college archt.

Wis., Milwaukee—City plans municipal power plant. $14,000,000. Applied for loan and grant under P.W.A. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

B. C., Elko—East Kootenay Power Co. development on Elk River at Phillips Canyon. Plans ready in April.

Ontario—Hydro Electric Power Comn. of Ontario, 616 University Ave., Toronto, F. A. Gaby, ch. engr., plans hydro-electric power development on Albany River in Patricia Dist. in Northwestern Section of Ontario, to serve new mines, in Crow River area, incl. dam, power house, turbines, generators, transformers, transmission lines, etc. $500,000.

Uruguay—State Electric & Telephone Administration prepared plans and will take bids in May, construction hydro electric plant on Rio Negro, capacity to be 530,000,000 kw. hr. per year. $24,000,000 voted by government.